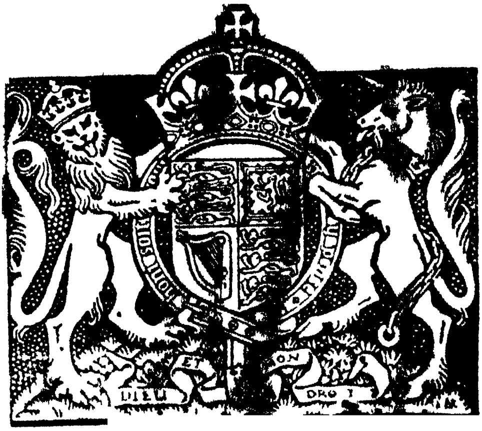

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RESEARCH INSTITUTE, NEW DELHI.

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VOL. XVIII.] APRIL, 1928. [No. 1.

The Genus *Clastoptera* in America North of Mexico.

KATHLEEN C. DOERING, Department of Entomology.

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16. Dorsal view of head, pronotum and scutellum. Fitch type. *C. proteus* subsp. *nigricollis* var. *d*. No. 736.

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27. Dorsal view. *C. testacea*. Female.

28. Dorsal view. *C. testacea*. Fitch type. No. 715.

29. Dorsal view of head and pronotum. *C. pini*. Fitch type. No. 721, var. *b*.

30, 31. Dorsal view.

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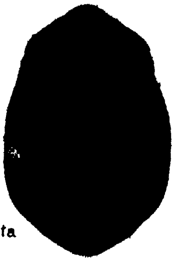
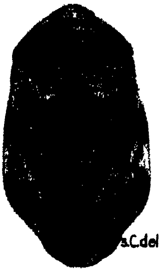
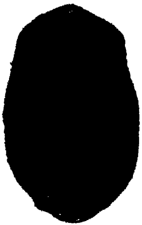
Dorsal views.

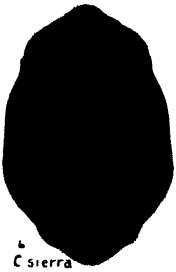
1 C binotata


2 C lugubris


3 C delicata

4 C lineatocollis


5 C brunnea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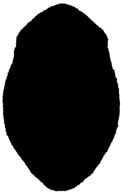
C sierra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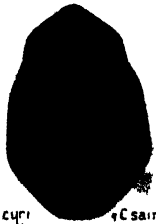
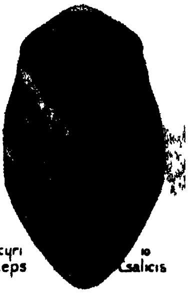
C hyperici

8 C saint cyri
var saint cyri


9 C saint cyri
var anceps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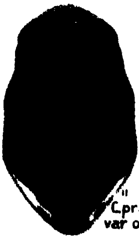
C salicis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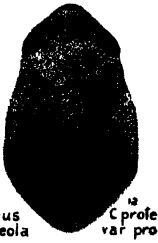
C proteus
var osceola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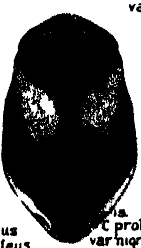
C proteus
var proteus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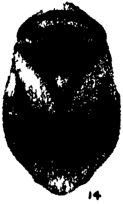
var nigricollis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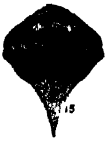
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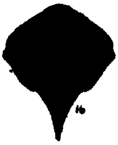
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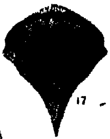
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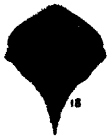
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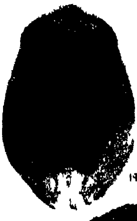
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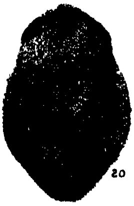
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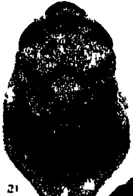
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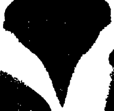
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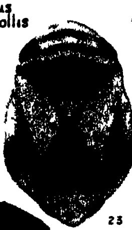
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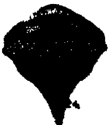
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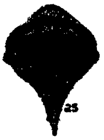
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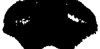
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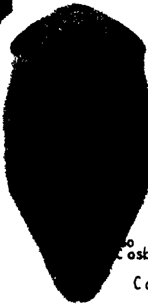
26
C testacea ♂

27
C testacea ♀

28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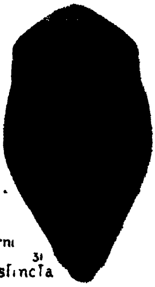
C osborni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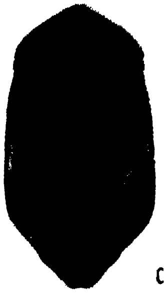
C distincta



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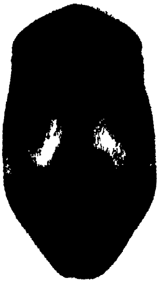

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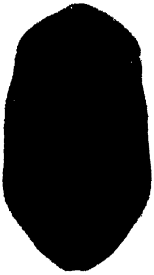
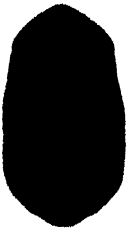
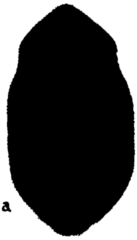


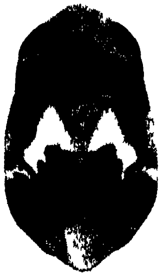
C obtusa var tristis



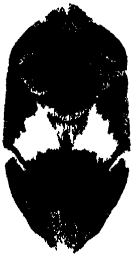
C xanthocephala
var xanthocephala



C xanthocephala
var unicolor



C lawsoni



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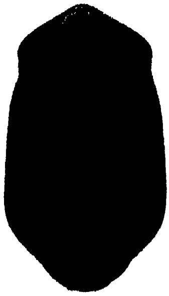

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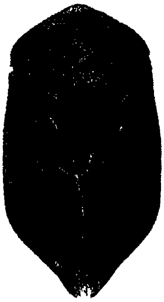

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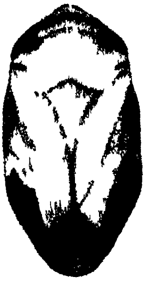
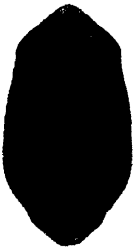


C canyonensia

C juniperina

C media



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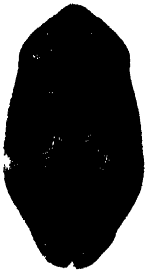

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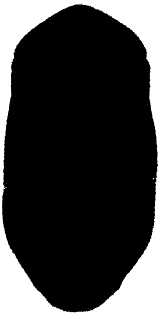

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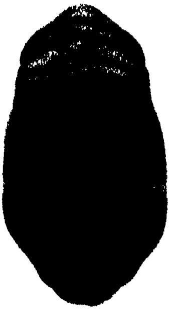

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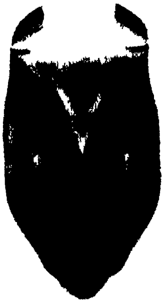

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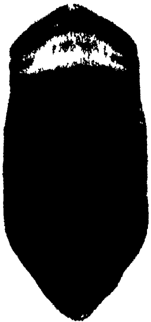

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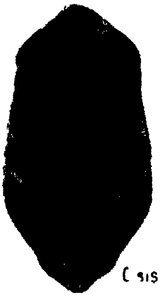
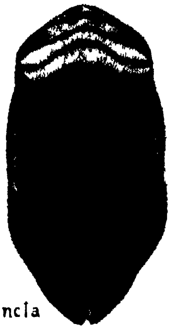


C siskiyou



C tricincta

INTRODUCTION:

HISTORICAL REVIEW.

THE genus *Clastoptera* was described by Germar in his *Zeitschrift für Entomologie* in 1838, in which he describes *Clastoptera xanthocephala* and *C. achatina*. However, Say described *Cercopis obtusa* in 1825, which later was placed in the genus *Clastoptera*. Fitch in 1851 described three species, *pini, testacea* and *proteus*. Of the latter he made numerous subspecies and varieties, based on slight color variations which are untenable. For this reason, and also because of his system of using Roman numerals and names to designate the subspecies, with the varieties under them designated by letter but without names, subsequent writers were greatly confused. This in part explains the many mistakes which have been made in the literature since that time. In 1854 Stål described *Clastoptera lineatocollis*, which, because of the vagueness of his description, in its turn has caused considerable confusion. In 1872 Provancher added his share to the general mix-up by writing a description of a so-called new species, which he called *Clastoptera saint-cyri*. Then in 1885 he changed this to a variety under the species *Clastoptera proteus* Fitch.

Certain workers have failed to notice this change and have attempted to synonymize certain species with *saint-cyri*, which later have proved to be varieties of *proteus* and not *saint-cyri* at all. Uhler in 1875 described *Clastoptera delicata*, which in the literature has been synonymized in various ways with other forms by all subsequent writers. In many cases it has been used interchangeably with *lineatocollis*, so that it is very difficult in many treatises to know which form the writer in question had in mind. In 1895 Gillette and Baker described another species, *Clastoptera osborni*, which brings us up to Doctor Ball's paper, published in 1895. To date this was by far the most complete paper on the genus *Clastoptera*. It was valuable at this time in that it served as a summary of the recognized species and varieties. However, as Doctor Ball (1927) himself states, "many mistakes in nomenclature and the interpretation of previous descriptions" were made in this paper, due for the most part to the "adoption of Fitch's method of presentation involving named subspecies and lettered varieties." But the writer is of the opinion that part of the confusion at that time, as well as at the present time, is due to Doctor Ball's belief that there are only four distinct species existing in the United States. The four species which he retained in 1895 were *Clastoptera proteus*, *Clastoptera delicata*, *Clastoptera obtusa*, and *Clastoptera xanthocephala*. In 1900 Baker published some critical notes on the genus, in which he attempted to straighten out the nomenclature. In general his changes were correct, especially in regard to making *binotata* and *osborni* distinct species instead of varieties. Van Duzee in 1912 described the variety *tristis*, which is still good, and the variety *glauca*, which, however, as Ball pointed out, is synonymous with Fowler's *Clastoptera unicolor*. He likewise made certain helpful criticisms and pointed out certain errors in nomenclature made by Doctor Ball, but incorrectly synonymizes *Clastoptera pini* with *proteus*. Doctor Ball in 1919 published a second paper on Cercopidæ in which he describes five additional varieties. Then in 1920 McAtee published a summary of the Cercopidæ taken around Washington, D. C., and the specimens contained in the National Museum collection. In this paper three new varieties are described, two by McAtee and one by Gibson. Another large systematic paper on the Cercopidæ was published by Stearns in 1923 in the Hemiptera of Connecticut. Finally in 1927 Doctor Ball published a revision of the genus north of Mexico, in which he still retains his four species and about twenty-five varieties.

PURPOSE OF PAPER.

From the historical account just given it is evident that the genus *Clastoptera* is in a state of much confusion. There is scarcely a species or variety in the entire group but what has been confused at some time or another with some other form. Moreover, no two writers have ever agreed about the various species and varieties. For this reason it has been apparent to many workers that a detailed revision of the genus was necessary. McAtee (1920) states:

> "The classification and nomenclature of this genus is much in need of revision The principal basis for the existing conception of the group is Doctor Ball's 1895 paper. This essay was prepared at a time when the proper differentiation of subspecies and varieties of nomenclature, also, were little observed. No one is more aware of its faults than its author, and it is to be hoped Doctor Ball [illegible] find time to give us a revised classification not only of this genus but of the whole family."

Accordingly in 1927 Doctor Ball published a revision of the genus in which he listed all the forms known to him, and added several new varieties. However, the writer felt, since Doctor Ball did not go into the structural details at all except to make a key to his four species and gave only brief color descriptions of the various forms, that a more detailed treatise based on structural studies and drawings of the genus would be useful. Doctor Ball's notes on distribution and food plants are very valuable in supplementing any work based on structural characteristics, but without the latter they are inadequate.

Therefore in this paper the writer has attempted to employ any and all structural characters that might possibly be of use in classification. Anyone who has worked with this genus will agree that it is a very difficult group to classify. Fowler (Biologia Centrali Americana) states that the members of this genus are "very variable in coloration, and it is almost impossible to distinguish them by descriptions." To substantiate his claim he gives the following quotation from Stål, in the Bidrag till Rio Janeiro, Trakten's Hemiptera Fauna, II, p. 16: "Species hujus generis non nisi coloribus inter se differunt, plurinæ difficillime distinguuntur et discribuntur; aliæ igitur certe aliarum tantum varietates." To this quotation he adds the following statement: "The punctuation and general size and shape, however, afford fair characters in some cases."

Doctor Ball (1927) makes the following statements:

> "The members of this genus are all small and globose and are easily separated from other Cercopidæ, but here the easy part abruptly ends. . . . Under the circumstances it is manifestly impossible to determine the number of species involved or to work out a stable nomenclature until extended collecting and careful life history has been done in the areas involved. . . . Some of these units may possibly be further divisible; if so, these divisions should also present good structural characters or certain definite and unchanging color characteristics, or both. Two or three times, during the course of the years, the writer has become convinced that some one form or other was distinct, only to find later that additional material from some other locality or season so thoroughly intergraded as to make it exceedingly doubtful. In general, the fewer the specimens the easier it is to believe that a distinct species exists."

Therefore, because of the difficulty in separating these forms, the writer considered it essential to make a study of the following characteristics: The inflation of the face; the extension of the front (tylus) beyond vertex; the width of the eyes as compared to the width of the head; the distance between the ocelli as compared to the distance between each ocellus and eye; the number and depth of the wrinkles on the pronotum; the length and general shape of the body, including the inflation of elytra; the margins of the elytra and the length of the elytron beyond the scutellum; wing venation, including size and shape of the apical callous (bulla); the number and length of the hairs on the wings; the external genitalia of both sexes, and the internal genitalia of both sexes where this was possible. In addition to these structural differences, certain color characters were used, namely, the color of the face and the general color pattern of the elytra and pronotum.

Not all of these characteristics were of equal importance in classification of this group. The most commonly used characters were the inflation of the face, the extension of the front, the wrinkles on the pronotum, the length of the body, size of the apical callous, the structure of the inner valve of the ovipositor, the color of the face, and, of course, the general color pattern. Of these, probably the two most valuable ones were the color of the face and the inner valve of the ovipositor. All of the other characters were used at various times to distinguish a few species from each other, but none of them, except the last two mentioned above and the color pattern, were used constantly to separate each species from every other species.

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DISTRIBUTION.

The genus *Clastoptera* is well distributed over the United States, specimens having been taken from practically all parts. They have also been taken extensively in Canada and Mexico. In fact Fowler stated that they were fairly common throughout North, Central and South America. Although Doctor Ball (1927) retained only four distinct species with twenty-five varieties, the writer cannot follow him in this respect. Instead, the writer maintains that there are thirty distinct species, with only six varieties. Of these species the ones which have the greatest range of distribution in the United States are *Clastoptera obtusa, C. xanthocephala,* and *C. proteus* var. *nigricollis.* Wherever these are taken they are usually collected in fairly large numbers, too. Other species which have been taken in large series are *C. osborni, C. delicata, C. lineatocollis, C. arborina, C. canyonensia, C. elongata* and *C. pallidocephala.* These, however, are apparently considerably limited in range.

MORPHOLOGY AND TECHNIQUE.

In order to make the discussion of the genus more complete and clear, it might be well to call attention to a few morphological facts which have not been mentioned in the following descriptions, and to explain the technique used in obtaining certain data and making certain drawings.

In the first place, all descriptions refer to female specimens. The males in the majority of cases differ from the females in several ways. They are always smaller, although this variation in size differs in the different species, some being only slightly smaller than the females, as in *xanthocephala,* while others are considerably smaller, as in *delicata.* Also, in the majority of species the males are much darker than the females, and often the front protrudes cephalad less than in the females. Secondly, in studying the wing venation it was apparent that there is no variation in the venation of the hind wing. Therefore this wing was not figured.

In order to study the wing venation of the elytra they were mounted on microscope slides in gum arabic. The drawings were made from these slides and therefore might not possibly always check exactly with the wings as they appear on the body, since the latter have not been flattened out as they have on the slides. In studying the hairs of the elytra the slides were again used and a drawing of the third anal cell was made, showing the distribution of the hairs on that region. By using an eyepiece scale marked off into squares, the distribution of the hairs in the various species can easily be compared by counting the number found in one square on a given part of the elytron. The Comstock-Needham system of nomenclature for the veins of the wings was used, based upon Metcalf's (1917) work on the tracheation of the nymphal wing pads.

The writer found that the external genitalia of both sexes cannot usually be used as a superficial characteristic in classification. This is due to the position in which they are held on the body. Normally they are bent dorsad at more or less of an angle to the body and thus are usually too much hidden by the elytra to be seen plainly. Therefore, in making the examinations and drawings of the genitalia the specimens were first relaxed and the pygofer dissected from the body. From an examination of plates it can easily be seen that the external male genitalia, except for distinguishing the larger groups, are of little value. The chief value of the external female genitalia lies in the proportional length of the ovipositor and the pygofer.

The internal genitalia, likewise, proved to be of little value in classification of the males, except to divide the species into four larger groups, namely *proteus, obtusa, arborina,* and *osborni* groups. If certain closely related species are studied side by side in a relative way it is usually possible to pick out minor differences, but these are difficult to point out and describe. Then, too, mere difference in size was occasionally useful.

The inner valves of the ovipositor fortunately are of great assistance in determining the species. The variations are not always outstanding, but no matter how slight they are they always appear to be constant for the species. To prove this, where the material was abundant, the writer made from four to six slides of the same species from as many localities as possible, and in every case where it was at all possible she made at least two slides. For this reason she is reasonably certain that the differences in the valves are constant. The outer valve was used in some cases, since it varies with regard to its general shape, the size of the membrane and in its relative length when compared with the ninth sternite. At first the writer thought there might be some variation in the number of hairs on this valve which would be a useful taxonomic character, but the differences proved to be negligible. The middle valve of the ovipositor in this genus is also of little systematic importance. At first glance it seemed that there were differences in these valves, but later investigation did not bear this out, except in a few cases where the base was greatly expanded. Perhaps more careful technique and study of these valves might reveal other differences.

DESCRIPTION OF GENUS AND KEY TO SPECIES.

ORIGINAL DESCRIPTION OF GENUS.

Kopf gross, stumpg dreieckig, so breit wie der Vorderrucken, Stirn gewolbt, queerstreifig, Scheitel breit viereckig, vorn und hinten scharf gerandet, die Nebenaugen auf der mitte des Scheitels genahert. Schnabel bis an die Hinterbrust reichend, Fuhler in einer Grube und der Wurzel der Wangen, sehr kurz, mit langer feiner Endborste. Vorderrucken breit am Scheitel vorgezogen and gerundet, bei den Augen gebuchtet, von den aber tief ausgerandet. Schildchen ein langgezogenes spitzwinkeliges dreick bildend. Deckschilde lederartig, an der Spitze gewolbt, uber einander klapfend, die hintere Randader weit von dem Hinterrande entfernt. Flugel hautig, unter den Deckschilden verborgen.

WRITER'S DESCRIPTION OF GENUS.

Form, small, globose, although extremely variable in size and color markings; head considerably wider than long, with the head and anterior part of pronotum at an angle with rest of body; vertex extremely narrow, slightly depressed transversely, anterior margin usually slightly carinated; ocelli placed midway between anterior and posterior margins of vertex, or nearer anterior margin than pronotum; eyes broad, on same plane with vertex; front extending cephalad beyond vertex in varying degrees, sometimes scarcely visible from above, in some forms equal to length of vertex; postclypeus not longitudinally carinated, inflated in varying degrees according to species; antennæ inserted in deep cavities between eyes and postclypeus; pronotum convex, broader than long, transversely wrinkled, anterior margin broadly rounded, lateral margins divergent, posterior margin deeply emarginate; scutellum triangular, much longer than wide; hemelytra pubescent, convex, deflected posteriorly, clavus with apex broadly rounded, corium terminating in a hyaline membrane, sometimes apical portion of corium also more or less hyaline with a conspicuous, usually protruding, callous spot near apex. Posterior tibia with a single terminal row of spines; ovipositor and male genital plates usually bent dorsad at an angle to rest of body.

KEY TO SPECIES.

PAGE

1. Few deep pronotal wrinkles or distinct bands, numbering twelve or less on median line; postclypeus generally greatly inflated....................2

Pronotal wrinkles many, usually numbering sixteen to twenty-five along median line, indistinct in *proteus* group, distinct in others; postclypeus generally moderately or slightly inflated, *saint-cyri* excepted....................11

2. Elytra fuscous-brown with a distinct, broad, white band across clavus; wrinkles numbering eleven or twelve along median line....................3

Elytra without white band; wrinkles or bands less than ten on median line........4

3. Front longer than vertex; size smaller, between 3.5 mm. and 3.7 mm. *C. arizonana* n. sp., 78

Front not more than two-thirds length of vertex; size larger, between 4 mm. and 4.5 mm. ....*C. lawsoni* n. sp., 71

4. Mostly black in color 5

Fuscous and brown, striped and banded in yellow....................8

5. Black with white spot midway on costal margin; other hyaline or light markings on elytra and face 6

All black above and below; front as long as or longer than vertex; length 4.6 mm. to 4.8 mm. ....*C. sierra* n. sp., 88

6. Postclypeus black with five or six pairs of light arcs anteriorly; elytra with apex brownish-hyaline and without clear hyaline areas around apical callous; length 3.75 mm. to 4 mm....................*C. binotata* n. sp., 30

Postclypeus without light arcs; smaller, elytra with more or less clear hyaline areas around apical callous 7

7. Postclypeus black except for occasionally faint indications on lateral margins. *C. brunnea* Ball (black male), 26

Postclypeus with a light band across posterior margin. *C. lineatocollis* Stal (black male), 20

8. Larger, elongate, measuring 4.5 mm. to 4.9 mm. in length; front usually longer than vertex 9

Smaller, measuring between 3.4 mm. and 4.3 mm.; front usually not over two-thirds length of vertex 10

9. Greenish-yellow or sometimes washed in fuscous with white veins in sharp contrast, *C. delicata* Uhler, 24

Bronze, or brownish with markings more or less obscure on elytra; arcs and spot on postclypeus more prominent ....*C. lugubris* Ball, 28

10. Yellow and light fuscous with prominent yellow veins; postclypeus yellow with light spot or band, preceded by five or six pairs of arcs..........*C. lineatocollis* Stal, 20

Darker, with markings less prominent; face mostly all black.......*C. brunnea* Ball, 26

11. Face with anterior portion shining black, rest bright yellow; wrinkles shallow or sometimes scarcely discernible 12

Face uniformly yellow or brown, or anterior portion at least chiefly yellow; wrinkles deep and usually fine 18

12. Body elongate, cell R_3 longer than wide, clavus striped in yellow and black, *C. salicis* Doering, 49

Body globose or pear-shaped; cell R_3 about equal in length and width; variously patterned 13

13. Body obovate, tapering at both ends equally; entirely black above, *C. hyperici* Gib.,

Body pear-shaped, widest posterior to middle; black, variously marked above with yellow and brown 14

14. Broad, with elytra greatly inflated; front approximately equal to length of vertex; black band on postclypeus two-thirds or three-fifths its length....................15

Semielongate, pear-shaped, elytra moderately inflated; front not more than two-thirds length of vertex; black band on postclypeus usually not more than one-half its length 16

15. Yellow and black striped species................*C. saint-cyri* var. *saint cyri* Prov., 46

All black above with brownish-hyaline apex.......*C. saint-cyri* var. *anceps* McAtee, 47

16. All yellow or washed in smoky hyaline..............*C. proteus* var. *proteus* Fitch, 40

Mostly black or marked with black....................17

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17. Base of clavus yellow .... *C. proteus* var. *nigricollis* Fitch, 41

All black above except for yellow bands on head and pronotum and hyaline apex, *C. proteus* var. *osceola* Ball, 43

18. Face entirely yellow or brown 19

Face yellow, variously marked with dark 21

19. Testaceous yellow, pronotum olive-green 20

Mostly black marked with pale yellow .... *C. testacea* Fitch (male), 60

20. Pronotal wrinkles deep, numerous, very irregular; apical callous light, *C. osborni* Gill and Bak., 56

Pronotal wrinkles less deep, regular, numbering about twenty-five on median line; apical callous dark .... *C. testacea* Fitch (female), 60

21. Pronotal wrinkles irregular, deep; body tapering posteriorly; striking black and yellow species .... *C. distincta* n. sp., 54

Pronotal wrinkles regular, moderately deep; body not particularly tapering posteriorly; color pattern varied 22

22. Very small, less than 4 mm. in length, *arborina* and *newporta* sometimes excepted .. 23

Larger, always 4 mm. or over in length 27

23. Uniformly dark brown or tannish-brown 24

Fuscous-tan with a more or less distinct white band on clavus 25

24. Uniformly dark brown .... *C. xanthocephala* var. *xanthocephala* Germ., 76

Yellowish-brown .... *C. xanthocephala* var. *unicolor* Fowler, 77

25. More slender with margins of elytra distinctly parallel; yellow band on pronotum obscure .... *C. media* n. sp., 99

More robust; yellow band on pronotum very distinct 26

26. Smaller, brown bands on pronotum and elytra very distinct, standing out in sharp contrast; front sometimes longer than vertex .... *C. arborina* n. sp., 94

Larger, more robust; more golden in color with brown markings less prominent; front generally equal to length of vertex .... *C. newporta* n. sp., 100

27. Front at least two-third's length of vertex 28

Front less than one-half length of vertex 31

28. Fuscous and brown with usually a faint oblique band across clavus and other dark brown marks on elytra; wrinkles numbering usually between sixteen and twenty 29

Uniformly pale yellow with no dark markings on elytra; wrinkles numbering approximately twenty-three on median line .... *C. canyonensis* n. sp., 80

29. Pronotum entirely yellow; elytra lighter tan or fuscous with markings and apical veins dark brown in sharp contrast; band on postclypeus and spots on genæ smaller .... *C. juniperina* Ball, 97

Pronotum banded with dark; elytra brownish-fuscous, veins and markings not particularly prominent; band on postclypeus and spots on genæ large, occupying central portion of face 30

30. Pronotum with three brown bands .... *C. ovata* n. sp., 90

Pronotum with middle brown band lacking .... *C. siskiyou* n. sp., 92

31. Posterior half of face black or sometimes mottled preceded by five or six pairs of arcs on postclypeus 32

Face yellow with a dark band across middle preceded by several pairs of dark arcs 34

32. Elytra fuscous-brown with an oblique white band across clavus 33

Elytra uniformly bronze fuscous .... *C. obtusa* var. *tristis* Van Duzee, 66

33. Elytra very dark fuscous-brown with a very distinct white claval band, *C. obtusa* var. *borealis* Ball, 67

Elytra fuscous, mottled, with white claval band much less distinct, sometimes only barely discernible .... *C. obtusa* var. *obtusa* Say, 65

34. Pronotum uniform yellow without brown markings; no white band indicated on elytra 35

Pronotum yellow with usually two or three brown bands present or at least indicated; a white band across clavus 36

35. Elytra light yellow mottled faintly with fuscous; band and arcs on postclypeus abbreviated at sides .... *C. uniformis* n. sp., 82

Elytra mostly dark fuscous except for anterior portion of clavus, which is bright tawny yellow .... *C. achatina* Germ., 69

36. Elytra lighter fuscous-tan with markings more distinct; median brown pronotal band broader and more prominent .... *C. texana* n. sp., 79

Elytra dark brownish-fuscous; median pronotal band narrow, frequently interrupted through middle 37

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37. Usually without brown bands on anterior margins of vertex and pronotum; arcs on postclypeus very faint ....*C. pallidocephala* n. sp., 87
    Brown bands distinct on vertex and pronotum; arcs prominent on postclypeus....38

38. Brown bands on vertex and pronotum very distinct, never interrupted, *C. tricincta* n. sp., 89
    Bands less distinct; median brown band on pronotum often interrupted, *C. elongata* n. sp., 84

DESCRIPTION OF SPECIES.

Clastoptera lineatocollis Stål.

(Plates III, IV, VIII, XII, XVI, XX, XXIV, XXV.)

Stal. Ofv. Af. K. Vet. Ak. Forh., p. 258; 1854.

ORIGINAL DESCRIPTION.

Patria, Cal. (St. Francisco).

Caput dilute flavescens, verticis marginibus basali et apicali lineisque transversis frontis apicem versus longitrorsum impressæ nigrofuscis. Thorax postice profunde angulato-sinuatus, medio longitrorsum carinatus, dilute flavescens, lineis pluribus transversis fuscis ornatus. Scutellum flavescens, ante medium vitta fusca, ut littera S fere formata, utrimque ornatum. Tegmina latitudine vix duplo longiora, sordide flavescente pellucida, medio fascia antrorsum angustata et abbreviata albida, anterius a linea, postice a fascia indistincta fuscis terminata, callo rotundata fere apicali ad marginem costalem nervisque apicalibus hic illic fuscis. Subtus nigro-varia. Pedes dilute flavescentes, vitta femorum maculis que tibiarum nigro-fuscis.

WRITER'S DESCRIPTION.

Size. Length: ♀ 3.9 mm. to 4.35 mm.; ♂ 2.92 mm. to 3.6 mm. Width: ♀ 2.1 mm. to 2.62 mm.; ♂ 1.8 mm. to 2.4 mm.

Shape. A medium-sized, semiglobose species with margins of elytra parallel and front greatly extended, but not as much as in *delicata* or *sierra*.

Color. A greenish-yellow species marked conspicuously with fuscous, dark brown and black. Front yellow, bordered anteriorly with brown. Vertex yellow with anterior black border usually reaching ocelli. Eyes brownish. Face yellow with dark markings as follows: The greater portion of postclypeus crossed by eight or nine pairs of distinct arcs, the last three pairs usually united to form an irregular spot or band of varying size, another band across posterior margin, usually all of anteclypeus except a light spot on each lateral margin, the antennal cavities, a black spot between eye and postclypeus and usually another below medioposterior corner of eye. Pronotum yellow or slightly greenish-yellow crossed by five to eight dark brown, slightly depressed bands, interrupted before lateral margins, the first one narrower than rest, not always indicated. Scutellum sometimes all yellow with only a narrow brown band across middle, occasionally interrupted through center, or in the darker forms this transverse band more pronounced and with two large triangular brown spots between band and base of scutellum. Elytra yellow, marked with fuscous and tannish-brown in varying degrees, clavus usually with the third anal cell more fuscous than the rest, a conspicuous blackish-brown spot at apex and the thick yellowish-white veins standing out in sharp contrast; corium either yellowish-tan or sometimes fuscous-brown, chiefly hyaline on apical portion and explanate costal margin, a distinct opaque yellow spot midway on costal margin, extending mesad across corium as an irregular narrow band, the latter preceded anteriorly by a short, oblique brown band, a smaller opaque yellow spot at base of costal margin, sometimes a yellow area in cell R_3 just cephalad of apical callous, another yellow area around apical callous, veins yellow, a dark cloud anterior to inflated portion of elytron, apical callous conspicuous and black. Legs, yellow, marked as follows: Coxa of first two pairs yellow anteriorly, rest black, trochanter with a cephalic brown spot, femur with a dark brown longitudinal band usually separated at apex by a yellow spot, tibia mostly yellow with two oblique dark bands, tarsus tannish-brown with dark brown claws. Hind leg, coxa and trochanter yellow on basal half, tibia black at base, rest yellow except a brown spot cephalad and caudad of the large lateral spine, the spines brown at base and black at tip. Mesothorax black, metathorax yellow through center and blackish-brown on margins. Abdomen mottled yellow and brown.

Majority of male specimens black above, except two brownish spots on vertex, a large conspicuous white spot midway on costal margin of each wing, the clear hyaline costal cell cephalad of apical callous, and an opaque yellow area in cell first M_4 and completely surrounding the apical callous. Face entirely black, except for a yellow band across anterior margin of postclypeus and yellow mandibular sclerites; light males same general color as females.

STRUCTURAL DETAILS. Vertex slightly depressed anteriorly, anterior margin carinated. Eyes level with rest of head, the width of the head being about three and one-half times the width of one eye. Ocelli located nearer the anterior margin of vertex than pronotum, the distance between the two ocelli slightly greater than the distance between each ocellus and eye. Front extending beyond vertex the length of the latter, or sometimes only two-thirds its length. Front greatly inflated, length of postclypeus approximately two and one-half times length of anteclypeus. Scutellum approximately one-fourth longer than wide. Elytra covered by a moderately long pubescence, the length of one elytron slightly over three times its width, base of costal margin flaring slightly, then parallel-margined to base of apical third, from whence it abruptly incurves to rounded apex. Wing venation, cell R_5 about equal in length and width, cell R_3 not much smaller than cell first M_4, apical callous round and bulbous, occupying only the cephalic half of cell R_1.

External genitalia: Pygofer of female, length and width approximately equal, exceeded by ovipositor about one-sixth of its length. Male genital plates broad at base, inner margins rounding to a blunt apex, exceeded by styles by about one-fourth their length.

Internal genitalia: Lateral valve of ovipositor broad, spoon-shaped, tapering to a roundingly pointed apex, basal laterodorsal angle membranous, ninth sternite two-thirds length of valve; inner valve flat, bladelike, broader in proportion to length than in other closely related species, united on inner margins for slightly over half their length, the free apical margins bearing two conspicuous notches, the one at point of union of the two valves and the other at base of apical third, and about 60 finely pointed teeth from basal notch to apex.

COMPARATIVE NOTES. *Clastoptera lineatocollis* resembles three other species very closely, namely *C. delicata*, *C. lugubris* and *C. brunnea*. In color pattern *C. lineatocollis* and *C. delicata* resemble each other perhaps more closely than any of the others, the color pattern of the two in some specimens being seemingly identical. The extreme light forms of *delicata* can usually readily be distinguished because they are a light greenish-yellow with less fuscous than the *lineatocollis* specimens have. However, sometimes *delicata* also has considerable fuscous on the elytra and then they are not so easy to separate, so that other characteristics have to be used. *C. lugubris* differs from these two species in color in that it is decidedly more bronze or brownish-fuscous, with the veins and markings much more obscure. On the other hand, even in the darker forms of both *delicata* and *lineatocollis* the veins are conspicuous, thick and yellow, making a sharp contrast to rest of elytra. *Clastoptera brunnea* frequently grades into *lineatocollis* in general color although as a general rule *brunnea* is more bronze and darker, somewhat resembling *lugubris*.

The other differences in color between these species pertain to the color pattern of the face. *Clastoptera brunnea* can be separated very easily from the other three by the fact that it usually has an entirely black face, whereas that of the other three are yellow with a transverse dark spot or band and dark arcs on the postclypeus, as given in the descriptions of each. It must be noted, however, that occasionally *brunnea* has faint touches of light on the lateral margins of the postclypeus and on the genæ with sometimes the mandibular sclerites mostly all yellow. Moreover, the dark spots on the postclypeus and genæ in *lineatocollis* are usually larger in proportion to the yellow areas than they are in *delicata*. Lastly, there is another color difference which sometimes aids in separating *C. lineatocollis* and *C. delicata*. Usually *lineatocollis* has six or seven, and frequently eight, dark bands on the pronotum, while in *delicata* the usual number is five.

Structurally these species differ in several ways. *Clastoptera delicata* is the longest species of the group, with the length of the clavus extending beyond scutellum usually equal or nearly equal to the length of the scutellum which is not true in any of the others, particularly *lineatocollis* and *brunnea* *C. delicata* also has a more pointed head, with the front protruding beyond vertex much farther than in any of the others, thus interrupting the rounding frontal curve of the head at point of union of gena and front. The postclypeus in *delicata* is greatly inflated, less in *lugubris* and *lineatocollis* and least of all in *brunnea*.

The size of these species also aids in separating them. *Clastoptera delicata* and *C. lugubris* are the two largest forms, being almost equal in size. *Clastoptera brunnea* is usually the smallest one in the group, and *C. lineatocollis* is about halfway between *delicata* and *brunnea*.

Lastly the ovipositors of these species differ notably. The inner valves of *delicata* are very long and broad, united for not quite a third of their length, the two notches are widely separated, and the margins between the basal notch and apex of each are alternately broken up into smooth areas and toothed areas, which is entirely different from any of the other species. The inner valves in *lineatocollis* are extremely short and broad, the notches are located very close together and the teeth are moderately fine and numerous, the valve of *lugubris* is more nearly like that of *lineatocollis* than *delicata,* having practically the same number of teeth as the former, but differing from it in that the valve is longer and much more slender, with the two notches spaced somewhat further apart and the apical notch distinctly roundingly produced. This valve of *brunnea* is also a short valve, but not as broad in proportion to its length as that of *lineatocollis,* and has much finer, more numerous teeth, and a rounding groove on its inner margin just before apical notch.

The black male forms in this group may also cause confusion in trying to classify them. Black males occur in *Clastoptera lineatocollis, brunnea* and of course *sierra,* since it is an entirely black species in both sexes. The writer was unable to find males of *binotata* in any of the collections which she had on hand for study. (For further discussion of this question, see distribution notes in the description of *binotata.*) The black males of these three species mentioned above, however, can easily be separated by the following differences: *Sierra* is entirely black above and below, and therefore lacks the conspicuous white spot on costal margin and any light markings on face; *C. lineatocollis and C. brunnea* both have this white spot on costal margin present, as well as a hyaline area of varying size preceding the apical callous and a yellow margin around the latter. In turn these two can be separated from each other by the color of the postclypeus which is entirely or almost black in *brunnea* but which has a lighter, irregular band across posterior border in *lineatocollis.*

These three species may easily be confused with the males of the following species, namely: *C. xanthocephala, C. saint-cyri* var. *anceps, and C. hyperici. C. xanthocephala* resembles the black males of *lineatocollis* and *brunnea* because it also has a white spot on the costal margin of the elytron, but it can be distinguished easily enough from these as well as from *sierra* by the fact that the pronotum has numerous fine wrinkles on it, while in the others the pronota are traversed by only a few deep ones. *C. hyperici* and *C. saint-cyri* var. *anceps* can be distinguished from the *lineatocollis* group by the color pattern of the face, which in the first two is of the *proteus* type wherein the anterior portion is shining black and the posterior portion is bright yellow, while the other three have black or mostly black faces as mentioned above. Likewise *hyperici* and *anceps* both have very faint, moderately numerous wrinkles instead of the few deep ones found in the *lineatocollis* group.

DISTRIBUTION. Doctor Ball states that he has taken this species abundantly in California and occasionally in Utah. In addition to these states they have been taken abundantly in Arizona and one specimen in the National Museum collection bears a Texas label. Another single specimen was taken in Eddy county, New Mexico. In the Snow collection, University of Kansas, there is a large series of 552 specimens. The majority of this large series were taken in Mescal, Cochise county, a few in Coconino county, and a few in the Santa Rita mountains, Arizona.

Of this large series 363 were females and 189 were males. In the males there were 158 black forms and 31 light ones.

HOSTS. Doctor Ball states that this species is taken abundantly on sage brush and mint in California.

Clastoptera delicata Uhler.

(Plates III, IV, VIII, XII, XVI, XX, XXIV, XXV.)

Clastoptera delicata Uhler. Uhler, P. R. Bul. U. S. Geol. Surv. I, p. 348; 1876.
Clastoptera delicata subsp. *binotata* Ball. Ball, E. D. Proc. Ia. Acad. Sci. III, p. 184; 1895.
Clastoptera lineatocollis var. *delicata* Uhler. Ball, E. D. Can. Ent. LIX, p. 105; 1927.

ORIGINAL DESCRIPTION.

Form of *C. proteus* Fitch, but with a more prominent front. .Pale greenish-yellow. Head broad, apparently impunctate; cranium short, transversely depressed, as is also the tylus; anterior edge of the vertex carinately elevated, bordered from eye to eye with a black line; eyes margined behind with black; front smooth, polished, bright yellow, rounded, the transverse rugæ substituted by slender black bands; lower down grooves, and with a broad, black spot, adjoining which each side on the cheeks is a smaller spot; under side bright yellow, rostrum black, reaching almost to the posterior coxæ; antennæ black at base. Pronotum banded on the anterior edge by a slender black line, and with five straighter and more slender lines, which stop just short of the lateral margins, these lines feebly impressed, and obsoletely, minutely scabrous; surface not wrinkled, almost smooth, moderately convex, deeply emarginated behind, the lateral margin narrowly produced as far as the outer line of the eyes; the humeral margin recurved, and with a small black dot before it. Scutellum pubescent, yellow, transversely wrinkled, with a slender black line at base and an interrupted one behind the middle. Hemelytra with a short, remote, golden pubescence, coarsely punctate at base, more obsoletely so posteriorly; the inner and posterior margins, the suture between the corium and clavus, an oblique short streak on the disk, and a spot on the middle of the costa fuscous; posterior margin of the corium with a sinuous brown band, the membrane and posterior one-third of the corium and a spot at base of costa pale brown, the bulla very prominent, black, under side yellow; the mesostethium, disks of the pleural pieces, and the middle line of the genital segment pitch-black. Legs yellow, the tibiæ having a band below the knee, another on the middle, and a third at tip and the spines of tibiæ and tarsi, including the nails, dark piceous.

Length to tip of hemelytra, 4½ mm.; width of pronotum, 2 mm.

Colorado and Utah.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 4.5 mm. to 4.95 mm.; ♂ 3.6 mm. to 3.9 mm. width: ♀ 2.47 mm. to 2.77 mm.; ♂ 2.1 mm. to 2.32 mm.

SHAPE. A large, semielongate species, tapering somewhat posteriorly and with a greatly protruding front.

COLOR. Greenish-yellow, marked conspicuously with dark brown and fuscous. Front yellow, crossed by three pairs of faint dark brown arcs. Vertex yellow, a black band across anterior margin reaching ocelli. Eyes golden-brown. Face yellow, marked with dark as follows: Nine or ten pairs of dark brown arcs and a posterior band across postclypeus, anteclypeus dark brown through middle, sometimes the posterior two or three pairs of dark arcs on postclypeus fusing together to form a dark spot, occasionally entire lower half of postclypeus and all of anteclypeus shining brownish-black. Pronotum bordered anteriorly by an irregular dark band, broadest through middle and narrowed at eyes, the disk crossed by four or five conspicuous dark brown bands, interrupted before lateral margins, and usually a shorter, fainter band just back of anterior border, sometimes, also, one to three faint lines or wrinkles on each posterior lobe. Scutellum yellow with a slender black line at base and another just behind middle, both usually interrupted through middle, sometimes in the darker specimens a conspicuous sinuate dark line on each side connecting the two transverse bands. Elytra yellowish-green and brownish-fuscous, clavus mostly yellow with the central areas of cells, an elongate spot on elytral margin laterad of each pronotal posterior lobe, and a large spot at apex light brownish-fuscous in the lighter forms, or extremely dark fuscous in the darker ones, with the thick, yellow veins greatly accentuated; corium yellow on basal two-thirds marked with light brown or deep fuscous as follows: A spot on costal margin just before middle becoming an oblique transverse band across middle, a border along the claval suture and a large cloud just before inflated portion of elytron, apical third clear tannish-hyaline except for the thick yellowish-white veins, the dark brown apical callous, surrounded by opaque yellow and an elongate thickened brown spot just anterior to cell M_2. Legs yellow, coxa of first two pairs with a dark band across middle, a dark spot on trochanter, a longitudinal brownish band on femur, a black band below knee of tibia, another on middle and a third at apex, sometimes a longitudinal band connecting these oblique bands, tarsus yellow or washed in brown with blackish-brown claws. Hind legs yellow with brownish, black-tipped spines, sometimes a brownish spot on femur and the tibia as above except for a yellow spot around larger lateral spine which divides the middle dark band. Mesothorax shining black through middle with yellow lateral margins. Metathorax yellow except for black lateral margins. Abdomen yellow, sometimes anterior segments dark and rest margined anteriorly with black, ovipositor always black.

Males resembling females in general color pattern.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin carinated. Eyes, length somewhat less than one-fourth the width of head. Ocelli located nearer anterior margin of vertex than pronotum and distance between the two ocelli equal to distance between each ocellus and eye. Front transversely depressed, greatly extended beyond vertex as much or usually more than length of vertex, the anterior curve of head interrupted at point of union of gena and front as in *C. sierra*. Postclypeus greatly inflated, its length approximately two and one-half times that of the anteclypeus. Pronotum minutely pitted, crossed by four, five or six depressed bands on median lines, commonly five, the first usually much shorter and less distinct, the sixth one, if present, merely a deep wrinkle instead of a band, usually one to three wrinkles on each posterior lobe, the first one sometimes a short, broad band instead of a wrinkle. Scutellum, length approximately two-fifths greater than its width. Elytra covered by a moderately fine pubescence, the length of one elytron approximately three times its width, base of costal margin flaring, then parallel-margined to apical half of elytron, from whence they taper to a bluntly pointed apex, length of clavus beyond apex of scutellum approximately equal to length of scutellum itself. Wing venation, cell R_5 about equal in length and width, cell R_3 much shorter than cell first M_4, apical callous round, bulbous, occupying about half of cell R_1.

External genitalia: Pygofer of female slightly wider than long, exceeded by ovipositor by one-seventh of its length. Male plates broad, divided on inner margins for about one-half their length, their mesocaudal angle bluntly rounded, exceeded by genital styles by about one-third their length.

Internal genitalia: Lateral valve broad, spoon-shaped tapering to a bluntly pointed apex, its laterodorsal margin membranous for half its length, ninth sternite approximately three-fourths its length; inner valve flat, blade-like, long, tapering to a pointed apex; the two valves united on inner margins for one-third their length, the free margins bearing fine teeth at scattered intervals and two conspicuous protruding notches, one at point of union of the two valves, the other at base of approximate apical third. Male styles broad, stout, basal apex extended into a flap, apical fourth at base bearing laterally a sharply pointed recurved hook, from whence it tapers to a dorsad-curving sharply pointed apex.

COMPARATIVE NOTES. See discussion of this subject under this heading in the description of *Clastoptera lineatocollis.*

DISTRIBUTION. Specimens have been collected from the following states: Arizona, California, Colorado, New Mexico and Utah. A large series of thirty-five or more specimens were taken by Doctor Lawson and Doctor Beamer at Pawnee Buttes, Colo. Another large series of about sixty specimens were collected by Doctor Beamer and Doctor Readio at Williams and in the Grand Canyon, Arizona. In all, the writer had available for study about 130 specimens, of which only 13 were males, a fact which indicates that the males of this species are rare.

HOSTS Doctor Ball states that this "species is abundant on rabbit brush (*Chrysothamnus graveolans*) in sheltered locations in Colorado and to a less extent on the sage brush in the western areas." Doctor Beamer and Doctor Lawson found the specimens taken at Pawnee Buttes on the rabbit brush mentioned by Doctor Ball In New Mexico and Arizona Doctor Beamer noted that they were taken on a sagelike plant, which again checks with Doctor Ball's data.

Clastoptera brunnea Ball.

(Plates III, IV, VIII, XII, XVI, XX, XXIV, XXV)

Clastoptera lineatocollis var. *brunnea* Ball. Ball, E. D. Ia Acad Sci XXVI, p. 147, 1919

ORIGINAL DESCRIPTION.

Smaller and less distinctly marked than *delicata.* Smaller than typical *lineatocollis* with less of a smoky and more of a bronzy cast, the lines and markings present, but obscure; face shining black.

Described from four examples from Alder and Rifle, Colo., collected by the writer. The smaller size and shining black face will at once distinquish this variety from the *lineata* relatives.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 3.45 mm. to 3.75 mm.; ♂ 3 mm. to 3.3 mm. Width: ♀ 1.95 mm. to 2.32 mm.; ♂ 1.87 mm. to 1.95.

SHAPE. A small, parallel-sided species with elytra only slightly inflated.

COLOR. Fuscous-bronze and yellow, marked with dark brown or black, very similar in appearance to *C. lineatocollis* and *C. lugubris*. Front, vertex, pronotum and scutellum as in the darker females of *lineatocollis*. Face outstandingly different from other closely related species by being entirely shining black, or occasionally with six or seven pairs of yellow arcs indicated on extreme lateral margins of postclypeus, mandibular sclerites sometimes yellow and sometimes touches of yellow around eyes or outlining a black spot on gena between postclypeus and eye and another just beneath caudomesal angle of eye. Elytra marked as in *lineatocollis* excepting that the clavus usually is more bronze-fuscous than in the latter, with the veins and markings less distinct. Rest of the body as in *lineatocollis* excepting that the dark areas are more accentuated.

Males of this species of two forms, the light ones resembling the females in color pattern and dark forms, entirely black above and below except for a yellow border around apical callous, preceded by a hyaline area and sometimes metathorax yellowish.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin slightly carinated. Eyes, length approximately one-fourth total width of head. Ocelli located nearer anterior margin of vertex than pronotum and distance between the two ocelli less than distance between each ocellus and eye. Front extended beyond vertex only one-half or two-thirds length of latter, less than in other closely related species Postclypeus moderately inflated, its length approximately three times length of anteclypeus, its width about one-half greater than distance between its lateral margin and outer margins of head. Pronotum crossed by six to eight distinct, slightly depressed dark bands, interrupted before lateral margins, anterior margin roundingly produced, lateral margins short and not greatly diverging, posterior margin deeply emarginate. Scutellum approximately twice as wide as long. Elytra approximately two and one-half times as long as wide, base of costal margin slightly flaring, then parallel-margined to base of apical fourth from whence it abruptly incurves to rounded apex Wing venation, cell R_5 about equal in length and width, cell R_3 smaller than cell first M_4, apical callous round, bulbous, occupying only part of cell R_1.

External genitalia: Pygofer of female slightly wider than long, exceeded by ovipositor approximately one-fifth of its length. Male plates broad at base, inner margins rounding to blunt apex, exceeded by styles about one-fifth or one-fourth their length.

Internal genitalia: Lateral valve of females broad, spoon-shaped, tapering to a bluntly pointed apex, its laterodorsal margin membranous for half its length, ninth sternite approximately three-fourths its length, inner valve flat, bladelike, rather broad and short but not as much as in *lineatocollis*, the inner margins united for half their distance, the free margins bearing fine, pointed teeth, numbering about one hundred and fifteen and two notches, the first at point of union of the two valves and the other just anterior to apical two-fifths, a deeply rounding groove cephalad of apical notch.

Male styles broad and stout, basal apex extended into a flap, apical fourth at base bearing laterally a recurved hook, from whence it tapers to a dorsad-curving, sharply pointed apex; connective roughly triangular; œdagus very short and broad, not much longer than connective itself.

COMPARATIVE NOTES. See discussion under this heading in the description of *lineatocollis.*

DISTRIBUTION. Specimens have been collected from Arizona, California, Colorado, Nevada, North Dakota and Utah.

LOCATION OF TYPES. Collection of Dr. E. D. Ball, Sanford, Fla.

HOSTS. Doctor Ball (1927) states: "The writer has taken this form commonly on sage brush (*Artemisia tridentata*) and in smaller numbers from rabbit brush on the western slope of Colorado, throughout Utah, and a few examples in the Bad Lands of North Dakota. Dr. J. McDunnough reports this from Lilloet, B. C., on sage brush."

Clastoptera lugubris Ball.

(Plates III, IV, VIII, XII, XVI, XX)

Clastoptera lineatocollis var. *lugubris* Ball Ball, E D. Ia. Acad. Sci XXVI, p 146; 1919
Clastoptera lineatocollis var. *lugubris* Ball Ball, E. D. Can. Ent. LIX, p. 106; 1927.

ORIGINAL DESCRIPTION.

Size and form of var. *delicata,* but lacking its definite marking. Dull smoky-brown with faint indications of the transverse bands on vertex and pronotum. A dark, smoky cloud just before the inflated portion of elytra and a large, shining black callosity. Face shining black.

Described from a single female from Alameda county, California, in the collection of the writer. Other examples from the same locality vary in having broader bands on the pronotum and the face with traces of light lines.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 4.65 mm. Width: ♀ 2 77 mm.

SHAPE. A large, semiglobose species with the front greatly extended.

COLOR. Dark tan or brown marked with yellow and dark brown. Front, deep yellow, with a dark brown band across anterior portion formed by the union of two pairs of dark arcs. Vertex deep yellow with a black band along anterior margin. Eyes gray-brown. Face, postclypeus yellow with eight or nine pairs of conspicuous dark brown arcs on anterior two-thirds, the posterior three pairs united through middle, thus forming a partial transverse band; another solid brown band on posterior margin, all of anteclypeus, a dark spot on gena, another beneath mediocaudal angle of eye and the antennal sockets dark brown. Pronotum dark tan with an uneven black border along anterior margin, disk crossed by seven or eight broad dark brown stripes, with the space between them more greenish in color and a brown spot on each lateral angle. Scutellum yellow with a dark spot at each basal-lateral angle, another midway down on each lateral margin, and a large median dark V. Elytra, clavus mottled with brown and fuscous, the third anal cell darker than the rest, veins yellow, greatly accentuated; corium tannish-brown, becoming clear hyaline towards apex, with a dark brown spot at base of costal margin, another midway down on costal margin, followed by a conspicuous yellow-white spot, which extends mesad almost to claval suture as a narrow white line, the latter bordered anteriorly by a distinct oblique dark brown band, posteriorly by a large, dark cloud, the large apical callous brownish-black. Legs yellow, conspicuously marked in dark brown as follows: Coxa of first two pairs yellow anteriorly, solid black posteriorly, trochanter with a cephalic brownish spot, femur with a dark brown spot on cephalic surface separated at apex by a yellow spot, tibia mostly dark brown on cephalic surface, except for two oblique yellow bands, tarsus tannish-brown with dark brown claws. Hind leg with coxa and trochanter yellow, femur, excepting posterior half, yellow, tibia yellow excepting the black base, a brown spot cepalad and caudad of lateral spines, and the lateral and apical spines which are brown at base and black at tip, tarsus yellow, with spines black at tip. Mesothorax black. Metathorax black on anterior portion, rest yellow. Abdomen with anterior segments black, caudal segments yellow, margined in black, pygofer and ovipositors mottled in brown and yellow.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin not distinctly carinated. Length of eye slightly over one-fourth the width of the head. Ocelli located nearer anterior margin of vertex than pronotum and the distance between the two ocelli being somewhat wider than distance between each ocellus and eye. Front extending beyond vertex more than length of vertex. Face, postclypeus moderately inflated, its length about two and one-half times length of anteclypeus, its width about one-third greater than distance between its lateral margin and outer margin of head. Scutellum two-fifths longer than wide. Elytra, their surface covered by relatively long hairs, length of one elytron approximately two and one-half times its width, base of costal margin flaring, then parallel-margined to apical third of elytron, from whence it abruptly incurves to rounded apex. Wing venation, cell R_5 length and width equal, cell R_3 smaller than cell first M_4, apical callous large and bulbous, occupying most of cell R_1.

External genitalia: Pygofer of female, length and width almost equal, exceeded by ovipositor about one-tenth or one-eleventh of its length.

Internal genitalia: Lateral valve of ovipositor broad and spoon-shaped, tapering to a bluntly pointed apex, its mediobasal half membranous, the ninth sternite about two-thirds the length of the valve; inner valve flat, bladelike, the inner margins of the two valves united for slightly over half their distance, with a small notch at point of union of the two valves and a more prominent protruding notch at base of apical third, and the free margins bearing approximately eighty-nine teeth.

COMPARATIVE NOTES. See the discussion under this heading in the description of *lineatocollis*.

DISTRIBUTION. Doctor Ball states that this species is known only from southern California.

LOCATION OF TYPES. Collection of Dr. E. D. Ball, Sanford, Fla.

Clastoptera binotata Ball.

(Plates III, IV, VIII, XII, XVI, XX.)

Clastoptera delicata subsp. II *binotata* Ball. Ball, E. D. Proc. Ia. Acad. Sci. III, p. 185; 1895
Clastoptera binotata Ball. Baker, C. E. Notes on Cercopidæ, Ent. News; 1900.
Clastoptera lineatocollis var. *binotata* Ball. Van Duzee, E. P. Cat. Hemip ; 1917.
Clastoptera lineatocollis var. *binotata* Ball. Stearns, L. A. Hemip. Conn., p. 288; 1928.
Clastoptera lineatocollis var. *binotata* Ball. Ball, E. D. Can. Ent. LIX, p. 106; 1927.

ORIGINAL DESCRIPTION.

Size variable; color from yellow to black; front much inflated; two circular yellow depressions on vertex near eyes; pronotum strongly, broadly wrinkled.

Front rising abruptly from face at sides, meeting vertex in same plane above, outline a regular curve. Vertex very slightly transversely depressed; a distinct, circular, yellow depression midway between eye and ocellus on either side. Pronotum coarsely pubescent, strongly, transversely wrinkled, about eight on the median line. Hemelytra coarsely pubescent; veins on clavus strongly raised; apical cells transversely compressed, third cell triangular, not reaching beyond angle of posterior marginal vein. Legs stout; spurs and spines strong; femur and tibia with dark lateral lines coalescing with two dark spots on outside of tibia.

Subsp. I, *lineata*. Pronotum yellow, with five black bands. Subsp. II, *binotata*. Pronotum entirely black.

HABITAT. Utah (Uhl.), California, 'Colorado and Arizona.

NOTES ON SYNONYMY.

In 1895 Doctor Ball called this form a variety of *delicata* Uhler. At this time he stated that this variety had been given the manuscript name, *Clastoptera binotata,* by Uhler. It was distributed under this name in collections.

In 1900 Mr. Baker pointed out that this should not be a variety, but a distinct species. He says: "I regard it as a good species. Among other things the pronotum in *binotata* is opaque and broadly, shallowly wrinkled, in *delicata* (*lineatocollis*) it is shining and nearly smooth. *Binotata* is further distinguished by the coarser sculpturing of the clavus. A variety of *binotata* occurs in California having a greater extent of light coloring along the costa and a transverse light band across lower part of face."

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 3.75 mm. to 4.05 mm. Width: ♀ 2.17 mm. to 2.47 mm.

SHAPE. A medium-sized blunt species with elytra only slightly inflated and margins distinctly parallel.

COLOR. A blackish-brown species with a conspicuous white spot on each wing. Head black with two light brown spots on vertex, and grayish-brown eyes. Face, all black, crossed by five or six pairs of yellow arcs on the anterior half of postclypeus and sometimes a faint spot in center of dark part. Scutellum black. Elytra black at base, brownish on explanate costal margin and apical third, with a conspicuous white spot midway on costal margin. Metathorax yellow. Abdomen black or blackish-brown. Legs yellow marked with brown as follows: Coxa of first two pairs dark brown, trochanter yellow washed in brown, femur yellow with a narrow longitudinal brown stripe on cephalic surface, tibia yellow with two oblique brown spots on cephalic surface, tarsus yellow with apices of segments margined in brown, claws dark brown. Coxa and trochanter of hind legs yellow, femur yellow except for the basal portion, a longitudinal narrow stripe lengthwise of each, and apical portion brown, tibia yellow with a brown spot at base, another between the two lateral spines and a third just caudad of second spine, the spines yellow at base and black at tip, tarsal segments washed in brown, with extreme tips of spines and tarsal claws very black.

STRUCTURAL DETAILS. Vertex not transversely depressed, anterior margin slightly carinated. Length of eye one-fourth the width of the head. Ocelli located half way between anterior and posterior margins of vertex, the distance between the two ocelli equal to distance between each ocellus and eye. Front extending beyond vertex about two-thirds the length of vertex, the anterior curve of head evenly rounded. Postclypeus moderately inflated, not as much as in *sierra*, its length almost three times the length of anteclypeus, its width about twice the distance between its lateral margin and outer boundary of head. Pronotum, roundingly produced anteriorly, lateral margins greatly diverging, posterior margin deeply emarginate, its surface roughly checked, also crossed by seven or eight deep wrinkles along median line and more at sides. Scutellum, length one-fourth greater than width. Elytra, approximately two and one-half times as long as wide, base of costal margin flaring, then parallel-margined to apical fourth of wing, from whence it abruptly incurves to blunt apex, their surface covered by moderately fine, short pubescence. Wing venation cell R_5, trifle longer than wide, cell R_3 smaller than cell first M_4, apical callous very large, bulbous, occupying basal two-thirds of cell R_1.

External genitalia. Pygofer of female somewhat wider than long, exceeded only slightly by ovipositor by about one-thirteenth of length of latter.

Internal genitalia. Lateral valve of ovipositor broad and spoon-shaped, rounding to a bluntly pointed apex its basal laterodorsal angles membranous, ninth sternite approximately two-thirds the length of the valve, inner valves flat, bladelike, tapering to a bluntly pointed apex, their inner margins united for half their length, their free margins bearing about ninety-three distinct teeth and two notches, the smaller one at point of union of the two valves and the other at base of apical third.

COMPARATIVE NOTES. *Clastoptera binotata* resembles *Clastoptera sierra*, *Clastoptera saint-cyri* var *anceps*, *Clastoptera hyperici* and *Clastoptera xanthocephala*, since all of these are more or less black or blackish-brown. It is distinguished from *sierra* by the fact that the latter has no yellow markings, while *binotata* has six or seven light arcs on the postclypeus and a whitish-yellow spot midway on costal margin of each elytron. Moreover, the general shape of the body is somewhat different, *sierra*, being a larger, more inflated species, with the elytral margins greatly diverging and the front considerably extended, while *binotata* is a more blunt species, with the elytra less inflated and the margins distinctly parallel. *Binotata* differs from *saint-cyri* var. *anceps* chiefly in that it is larger and has all black elytra and face while *anceps* has the apex of elytra light brown and the posterior half of postclypeus bright yellow. *Binotata* also resembles *hyperici,* but differs in that the lower half of the postclypeus in *hyperici* is bright yellow, while in *binotata* the face is entirely black, with five or six pairs of light arcs on the anterior half of the postclypeus. Moreover *binotata* has the two white spots on the elytra, which are entirely lacking in *hyperici.* Lastly, superficially *binotata* resembles *C. xanthocephala,* since they are both dark colored species and their general shape is similar, both having parallel-sided elytra which are bluntly tapered at apex. They can be distinguished by the general color, which in *xanthocephala* is blackish brown while *binotata* is more black, and by the color of the postclypeus, which in *xanthocephala* is yellow with a dark transverse band across middle, preceded anteriorly by dark arcs, while in *binotata* the postclypeus is all black except for the anterior light arcs. Then *binotata* differs from these last three species very decidedly in the pronotal wrinkles, *binotata* having a few very deep wrinkles, *Clastoptera hyperici* and *Clastoptera saint-cyri* var. *anceps* comparatively few but exceedingly shallow ones, while *xanthocephala* has many shallow wrinkles.

The ovipositors of these five black or blackish-brown species furnish another good distinguishing character. The inner valve of *sierra,* which of course more closely resembles that of *binotata* since they belong in the same large group, is much longer and more slender than that of the latter, with the distance from apical notch to apex of valve proportionally shorter, and with two other notches indicated cephalad of it instead of just one as in *binotata;* moreover, the teeth of *sierra* are larger and less in number than in *binotata,* there being about 93 in the latter and 68 in the former. The differences in the valve of the other three can easily be seen by a glance at the figures; *hyperici* has a short, broad valve with apical notch almost entirely lacking; the var. *anceps* has a longer but also a broad valve with the two notches widely separated, and *xanthocephala* has a very small valve with the notches only slightly indicated. The teeth in *hyperici* and *xanthocephala* are fine, numbering about 110 in the former and about 78 in the latter, while in *anceps* they are larger, numbering about 108.

For discussion of the males of related species see page 23.

DISTRIBUTION. Doctor Ball states that this species "occurs from the Rocky Mountains in Colorado, west to California and southward. Common on the sagebrush." However, since there has been so much confussion in regard to the black males of this group it is possible that some of the males of *Clastoptera sierra* and *lineatocollis* have been confused with this species.

The writer is inclined to believe that no males of *binotata* have been collected. Just how they would differ from those of *sierra* it is hard to determine. As Doctor Ball suggests, the best way, perhaps, would be to depend on locality labels which show that males and females have been taken together, and that no other species was confused with it.

In regard to this question Doctor Ball (1927) stated: "The males of *binotata* are much smaller and have the face all black, and may lack the light markings along costa." In a letter to the writer he also made these remarks: "The only way that I have of placing the black males of all varieties, except *delicata* is that they have been collected with the females where only the one variety was found in the place. Most of my collecting was done before the varieties were differentiated, and there should be a considerable amount of study in the field of the relationship of these forms, and especially of the relation of the sexes. Males of *delicata* are almost always scarce, while on the other hand the black males of *brunnea* and *lineatocollis* are abundant. As the black females of *binotata* are themselves rare, and have been rarely taken where they are free from possible contamination with the other forms, it is difficult to segregate their males."

LOCATION OF TYPES. Holotype and allotype in the collection of Dr. E. D. Ball, Sanford, Fla.

HOSTS. Sage brush.

Clastoptera sierra sp. new.

(Plates III, IV, VIII, XII, XVI, XX, XXIV, XXV.)

SIZE. Length: ♀ 4.65 mm. to 4.8 mm.; ♂ 3.75 mm. Width: ♀ 2.7 mm. to 3.3 mm.; ♂ 2.4 mm.

SHAPE. A large, robust species. Males much smaller, approximating the size of the females of *lineatocollis* and *brunnea.*

COLOR. An entirely black or brownish-black species, except for two light brown spots on vertex and the golden-brown eyes. Elytra black, becoming reddish-black on distal portion. Mesothorax black. Metathorax light. Abdomen and legs black.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin slightly elevated. Eyes with their greatest length less than one-fourth the width of the head. Ocelli located slightly nearer anterior margin of vertex than pronotum, the distance between the two ocelli equal to the distance between each ocellus and eye. Front extending beyond vertex a distance approximating the length of the vertex. Postclypeus greatly inflated, length about three times the length of the anteclypeus. Pronotum rough, anterior margin roundingly angulate, lateral margins greatly diverging, posterior margin deeply emarginate, anterior portion of pronotum and head at an angle with rest of body, wrinkles across disk few and deep, numbering about ten along median line. Scutellum roughly wrinkled and pitted, its length about one-half of width. Elytra greatly inflated, length of one slightly more than twice its width, base of costal margin flaring, then only slightly diverging to apical third of elytron, from whence it abruptly incurves to rounded apex, its surface roughly wrinkled, covered by a moderate number of short hairs. Wing venation, cell R_5 equal in length and width, cell R_3 smaller than cell first M_4, the apical callous large, bulbous, occupying most of cell R_1.

External genitalia: Female pygofer longer than wide, exceeded by ovipositor about one-fifth of its length. Male plates broad at base, inner margins rounding to a blunt apex, exceeded by genital styles about one-third or one-fourth their length.

Internal genitalia: Lateral valve of ovipositor broad, spoon-shaped, tapering to a bluntly pointed apex, the basal two-fifths membranous on dorsolateral angle, the ninth sternite over half the length of the valve. Inner valve flat, bladelike, narrow, tapering to a roundingly pointed apex, the basal half of the two valves united, the free apical margins bearing three notches, one at point of union of the two valves, another at base of apical third, and the other one-half way between these two, the margin from the apical notch to apex of valve bearing distinct teeth, numbering approximately 68. Male styles broad and stout, basal apex extended into a flap, apical fourth at base, bearing laterally a recurved hook, from whence it tapers to a dorsad-curving, sharply-pointed apex; connective roughly triangular, about twice as wide as long, œdagus a straight rod with rounded apex, in situ the apical portion being bent dorsad.

COMPARATIVE NOTES. *C. sierra* superficially resembles other black species in the genus, but differs from all of them by the fact that it is entirely black above and below. It is thus separated from *hyperici*, which is also chiefly black above because the latter has the lower half of face bright yellow. Moreover, *hyperici* has very shallow wrinkles on the pronotum while *sierra* has only a very few but decidedly deep ones.

For the comparison with *binotata*, see the discussion on page 31 under this heading; and for comparison with the males of other black species, see the discussion on page 23 in the description of *lineatocollis*.

DISTRIBUTION. The species was described from eight specimens in the National Museum collection, collected by Coquillett and C. F. Baker. Four females and three males of this series were collected at Sierra Nevada, Cal., and another male was taken at San Bernardino, Cal.

LOCATION OF TYPES. Holotype and allotype in the National Museum collection, Washington. D. C.

HOSTS. Unknown.

Clastoptera proteus Fitch.

(Plates III, V, IX, XIII, XVII, XXI, XXIV, XXV.)

Fitch, Asa. Homoptera. New York State Cabinet of Natural History, p. 53; 1851.

ORIGINAL DESCRIPTION.

Head bright yellow, a black band on anterior margin of the vertex and a broader one on the front; front polished, without transverse striæ; a callous black dot near the apex of the elytra; legs yellowish-white. tarsi black. Length, 0.16; males slightly smaller. Abundant on the panicled dogwood (*Cornus paniculata*). Closely allied to *C. atra* (Germar), but on examining a host of specimens not one occurs in which the legs are annulated with black or fuscous. No. 722, female.

This pretty insect, though so small in size, presents an astonishing number of subspecies and varieties so clearly and distinctly marked that at first glance they would be confidently regarded as well characterized species. The following are the more prominent, though by no means all, of the varieties that occur:

Subspecies I—*flavicollis*. Thorax entirely yellow.
  var. *a*—Elytra yellow. No. 723.
  var. *b*—Elytra with an oblique, blackish vitta. No. 724.
Subspecies II—*cinctocollis*. Thorax with a black band.
  var. *a*—An interrupted black band on anterior margin of the thorax. No. 725.
  var. *b*—An entire black band on anterior margin of the thorax. No, 726.

Subspecies II—*cinctocollis*—Concluded.
  var. *c*—Thoracic band crossing the disk instead of the anterior margin. No. 727.
  var. *d*—Band on the disk of the thorax, and scutel black. No. 728.
Subspecies III—*maculicollis*. Thorax with one or two discoidal spots.
  var. *a*—A black spot on the disk and interrupted band anteriorly. No. 729.
  var. *b*—A black spot on the disk and anterior band entire. No. 730.
  var. *c*—Two black spots on the disk of the thorax. No. 731.
Subspecies IV—*nigricollis*. Thorax black, with a yellow band forward of the disk.
  var. *a*—The black band on anterior margin of thorax interrupted. No. 733.
  var. *b*—The band continuous. No. 734.
  var. *c*—Scutel black, with a yellow dot at its base. No. 735.
  var. *d*—Scutel entirely black. No. 736.

AUTHENTICITY OF THE FITCH TYPES.

Clastoptera proteus and its many subspecies and varieties, described by Fitch in 1851 have been, for some reason, the source of much confusion to systematists in this group ever since that time. In the literature one can scarcely find any two writers agreeing on any one form. Moreover a number of mistakes in nomenclature have been made. The result is that the group has been woefully mixed up from beginning to end. It would appear, then, that the first and easiest thing to do in settling the question would be to study the Fitch types themselves. However, this does not prove to be the simple task it at first seems to be. In the first place there has been some misunderstanding in regard to the location of the Fitch types The National Museum authorities are inclined to believe that they are found in the National Museum collection, while others maintain that they are to be found in the Albany State Museum. This question has been investigated by Dr. Herbert Osborn quite thoroughly. In a letter to the writer he remarks:

> "My opinion is that where the numbers on the specimens agree with the numbers in Fitch's published description they should be types, although where specimens in the National Museum agree with those at Albany there would of course be no debate as to what the species is. The National Museum set was, as I understand it, a duplicate set kept by Doctor Fitch, and after his death sold with other material, and finally acquired by the National Museum. In some respects it might be thought more authentic than the set deposited in Albany, but the fact is that for many of the species, at least, the numbers given in the descriptions coincide precisely and references to sexes agree with the specimens in Albany. In such cases there seems little room for doubt that the Albany specimens were the ones actually used for description."

On the case containing the types at Albany is pasted a label which Dr. E. P. Felt states was placed there by Mr. Lintner. The wording of this label is as follows: "Arranged by Doctor Fitch in 1850. Transferred to this case in 1879. Contains 575 species and 5 subspecies of types of Doctor Fitch."

Furthermore, in Lintner's Ninth Report of the State Entomologist of New York, which contains a copy of Fitch's original paper, Lintner gives the following explanation as a preface to the latter:

> "The case of Homoptera, arranged by Doctor Fitch to accompany and illustrate the catalog—each specimen indicated by name and number cut from the catalog—was placed in the collections of the New York State Cabinet of Natural History in 1850. During ensuing years it became infested with *Anthrenus* and other museum pests and a number of specimens were destroyed. In 1879 those that had escaped destruction were removed and arranged with the original labels in a new case, which has since been in charge of the state entomologist in his office in the capitol. A slip attached to the case states that it contains the types of fifty-four species and five subspecies described in the catalog. The Psyllidæ were all destroyed; of some of the Aphididæ portions are remaining. In the other families, the structural features remain for comparison, *but the colors have become so seriously impaired that they would be almost valueless for study.*"

During the summer of 1927 the writer was fortunate enough to be able to study the type specimens which are kept in the Albany Museum. The specimens in this collection all check according to number with the published description. However, it was very disappointing to find that, as mentioned by Lintner, some specimens had been destroyed and all the specimens were considerably faded. In fact they were so faded that superficially all the specimens appear to be yellow. Yet that they *have* faded cannot be doubted when the following facts are considered: First, the fact that Lintner mentioned that the colors of a great many of the Fitch types were so impaired as to be valueless for study. Secondly, the fact that no black was found on any of the eleven specimens which have been preserved, while in the published descriptions Fitch mentioned black in several places. Still a third reason for believing that they have faded is that the type specimens of *Clastoptera pini* Fitch, in the same collection, are yellowish forms, while *pini* characteristically is a uniform black species. Lastly certain specimens in the National Museum collection, which are supposed to be duplicates of the Albany ones still retain the black marks mentioned by Fitch in his original description.

As for the National Museum specimens they apparently cannot be taken as types. In a sense they might be ranked as paratypes. They have been preserved much better than the Albany species, in that they have not faded to the degree that the latter have. In this respect they have been of value in determining the true color of the real types, since Doctor Fitch must have had them before him when he wrote his descriptions. The labels on them, however, seem to be more or less valueless as the specimens do not check accurately with the corresponding labels on the Fitch types at Albany. This might be due to the fact that Fitch used color characteristics that are untenable, as will be discussed later under description of color.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 3.6 mm. to 4.2 mm. Width: ♀ 2.4 mm.

SHAPE. A pear-shaped species, of medium small size, more obovate than *hyperici* or *saint-cyri,* and yet not as elongate as some other species in the genus such as *osborni* and *salicis*.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin barely carinated. Front (tylus) anteriorly rounding and extending beyond vertex for at least two-thirds the length of the latter. Ocelli located about halfway between the anterior and posterior margins of the vertex and the distance between the two ocelli about one-half the distance between each ocellus and eye. Length of eyes about one-fifth total width of head. Postclypeus greatly inflated, arising abruptly from sides of cheeks when viewed ventrally, length about one and three-fourths times the length of the anteclypeus, width somewhat greater than combined width of one gena and eye. Pronotum bare and shining, broadly and shallowly wrinkled with the wrinkles sometimes hardly distinguishable, and numbering from twelve to sixteen or seventeen, anterior margin rounding, posterior margin deeply emarginate and lateral margins diverging. Scutellum about two-thirds as wide as long. Elytra, length of each elytron about two and one-half times greater than width, narrow at base, then lateral margins diverging so that the widest part of body is just anterior to a line extending from apex of clavus to costal margin, from which point it abruptly incurves to rounded apex, its surface bearing relatively few hairs as compared with the other members of this group. Wing venation, cell R_5 of elytron slightly wider than long or as wide as long, cell R_3 shorter than first M_4, apical callous (bulla) round and comparatively small, occupying only approximately half of cell R_1.

External genitalia: Pygofer of female, length equal to width, exceeded by ovipositor by one-third of its length, ninth sternite about one-half length of lateral valve of ovipositor; male genital plates broad at base, inner margins rounding to a blunt apex, separated approximately three-fourths their length on median line, with styles exposed beyond genital plates about one-fourth length of latter.

Internal genitalia: Lateral valve of ovipositor roundingly pointed; dorsal valve with basal half of inner or dorsal margins united, the free apical margins bearing coarse, shallow, irregular teeth, approximately eighty in number and two notches, a smaller and almost indistinct one at point of union of the two valves, and a much deeper one at apex of middle third of valve; inner valve bladelike, narrow at base and tapering to a slender apex. Male style broad and stout, base extended into a flap and base of apical fifth bearing laterally a recurved hook, after which it tapers to a dorsad-curving, sharply pointed apex; connective roughly triangular, twice wider than long, œdagus a straight rod with rounded apex.

The writer has retained three color varieties for this group, namely *proteus*, *nigricollis* and *osceola*. The reasons for doing this are set forth in the following paragraphs.

Fitch in his original description makes four subspecies and thirteen varieties, based entirely on color characteristics of pronotum and scutellum. He mentions the elytra only with reference to the varieties of the subspecies *flavicollis*. Furthermore he states that there are an astonishing number of these varieties and says that those which he described in his paper are the "more prominent, though by no means all of the varieties." From this it may be inferred that Fitch had on hand a series of specimens which varied in color a good deal but which he nevertheless considered as one species. It was unfortunate that he chose color characteristics of the pronotum and scutellum only on which to base his varieties, as these appear to be too unstable for use. Moreover, he complicated things still more by being none too clear in his description of the type form. As a result subsequent writers for some reason, perhaps because of its greater numbers, got into the habit of calling the dark form which has the yellow and black areas in sharp contrast, and which Fitch described as his subspecies No. IV, *nigricollis,* as the typical form of *proteus.* Then when a study of the types at Albany was made it was surprising to learn that the type specimen bearing the number 722, which is the first in the series of Fitch's description, has no black on the wings at all. Also, at first glance it appeared that all the other specimens were yellow forms. If this were true, it was apparent that the abundant yellow and black form so commonly taken for *proteus* would have no place among the Fitch varieties. Doctor Ball (1927) is inclined to this opinion and gives the following interpretation of the Fitch types:

> "Fitch's description is incomplete as he does not mention the color of the pronotum, scutellum or elytra, and the writer inferred that he was describing the common form, with the yellow and black areas on these parts in sharp contrast, and in this all subsequent revisers have apparently concurred. Imagine, therefore, the surprise to find the type of *proteus* a pure yellow with only the narrow band on vertex and the bulla black. Fitch described *all the black* there was, and simply failed to mention the yellow parts. The writer suggested that all Fitch's subspecies belonged to the yellow group, and in that he was correct, but he did not expect to find the species itself to be the yellowest of all. Fitch's subspecies were discarded, partly because the writer did not know that the rules gave them the same status as species names, and partly because at that time the types were supposed to be lost and it was not thought possible to tell what they were, as only one color character was given. On studying the types, which are well preserved, it was found that the one color character given is all they have in *addition to that given for the species. And what was given for the species was all it had,* so the combination makes a complete description in each case.
>
> "Fitch's subspecies all belong to the yellow group which was included under *flava,* and will hereafter be known as *proteus,* but as they, in their variations at least, represent different lesser types, they may be retained by those who wish to subdivide."

The writer, however, after studying the Fitch types at Albany, as well as the so-called Fitch types at the National Museum, together with other interesting data obtained, is unable to agree with Doctor Ball entirely in regard to these forms. In the first place Doctor Ball seems to have ignored entirely the question of fading. That this has happened seems apparent for the reasons explained in a preceding paragraph. To make this matter clearer it might be advisable to describe the type specimens in detail, at the same time comparing them with the published description. The specimens numbered 722, 723 and 724 in the Albany collection have the head, thorax and base of clavus an opaque yellow, while the rest is more or less hyaline yellow of a grayish cast. The band on clypeus and vertex is light brown and the bulla is yellow. (See paintings.) In his description Fitch speaks of "a black band on the anterior margin of the vertex in No. 722, and a broader one on front; a callous black dot on apex of elytra." He distinguishes No. 724 from the other two by the presence of an oblique, blackish vitta on the elytra. The specimen now has the vitta faded to a light brown.

Only two varieties of the second subspecies, *cinctocollis,* were preserved, No. 726 and No. 728 not being found in the collection, evidently having been destroyed. No. 725 and No. 727 are like the varieties of *flavicollis* in regard to the elytra. The yellow pigment of the head, thorax and clavus is distinct, while the rest of the wing is a pale, greyish-tan or more or less hyaline. In his description, Fitch separates these from the other subspecies by the presence of a black band either on anterior margin or crossing the disk of the pronotum. In the type specimens the so-called black bands are a light or faint brown, sometimes barely discernible.

The third subspecies, *maculicollis*, Fitch characterized as having one or two black spots on disk. In all cases the spots were very light brownish instead of black. In No. 731 there was no indication of two black spots at all, as mentioned in the description, but rather the entire posterior half was washed in a light brown.

The last subspecies mentioned by Fitch is *nigricollis*, of which he says: "Thorax black, with a yellow band forward of the disk." He makes four varieties based on variations of the black band and color of the scutellum. The types of *nigricollis* have evidently undergone the same degree of fading as the others. Here the typical opaque yellow stands out plainly, but the rest of the elytra is a distinct tannish-brown, distinctly darker than any of the types of Fitch's other subspecies, indicating clearly a pattern derived by the fading of the black wings of the common yellow and black form, commonly termed var. *proteus* and lately called var *flava* in Ball's last paper. No black, of course, was found on head and thorax, but was replaced by a light brown as in all the other preceding forms. The variations of the scutellum in this subspecies described by Fitch can be duplicated in our present-day collections of the common form.

It seems logical to suppose, therefore, that since the parts that were described as a deep or shining black, such as the band on the face, and the markings of the thorax, have faded to a light brown; that the brownish coloring of less intensity on the hyaline corium has also resulted from the fading of black markings on the elytra. A number of specimens on hand for study at the present time suit the description of the subspecies *cincticollis* and *maculicollis* in regard to head and thorax, but they all have the elytra washed in smoky-grey or brown. Similarly specimens of *nigricollis* show the elytra black.

In view of the above facts the writer thinks that in the large sense, *Clastoptera proteus*, Fitch would include forms varying from those which are mostly yellow to those that are almost entirely black. Furthermore that in this group there are only three color varieties that are substantial enough to be of service in classification. The color characteristics of thorax and scutellum which Fitch used are too variable to be of any use. One can find any number of variations of these characters, and they all grade into each other so slightly that it would be impossible to name them all. From a study of some four hundred specimens they seem to fall into three more or less distinct groups. Thirty-eight of these were of the all black type, thirty-eight of the yellowish or smoky forms with yellow pronota, and all the rest were the common variety where the yellow and black areas on the elytra stand out in sharp contrast. The latter has the thorax black with a yellow band cephalad of the disk, as described by Fitch under his subspecies *nigricollis*. In this series of over three hundred specimens the thorax is always of this type. Therefore it seems evident that it was the form described as *nigricollis* by Fitch and that it has very stable characteristics. Moreover, in the duplicate collection owned by the National Museum there are specimens of this common variety showing this coloration distinctly, so that Fitch evidently had them before him when he made his original descriptions. The name *flava*, given to this form by Doctor Ball, would therefore be synonymous with Fitch's *nigricollis*. For the extreme black form the writer retains the name *osceola*, given to it by Doctor Ball (1927). It is easily distinguishable from all other *proteus* forms by its extreme blackness, so that it warrants varietal standing without a doubt. This, then, leaves the yellowish forms to be taken for the true variety *proteus*. This variety includes Fitch's subspecies *flavicollis*, *cincticollis* and *maculicollis*, or in other words all the forms having either an entirely yellow pronotum or bearing various slight markings of brown or black, and with the elytra yellow at base of clavus, and rest either hyaline or washed in varying shades of smoky-brown. In some cases the elytra almost border upon those of *nigricollis*. For this reason certain workers might prefer to differentiate between those having the elytra yellow or hyaline and those with the smoky or darker ones. Doctor Ball (1927) described a new variety, *Clastoptera proteus* var. *seminuda*, which is of the smoky type. Since the thorax fits the description of Fitch's subspecies *cincticollis*, and if one takes into account the fading of the original type it seems to the writer that they are the same thing. In that case, if one were desirous of making a variety of this smoky form it would have to bear the name *cincticollis*. However, since the coloring of the thorax, as well as the amount of dark on the elytra in these yellowish forms, seems to be very variable it hardly seems advisable to try to separate them too carefully. Besides it is possible that these specimens are teneral forms which were taken before they had a chance to acquire their full coloring. This has occurred in other species of Cercopidæ and it is not unlikely that it could have happened here. But since this is hard to demonstrate satisfactorily, and since Fitch evidently took all yellow specimens for his type, and his subspecies *flavicollis* at least, it will have to stand as the true *proteus*.

Clastoptera proteus var. *proteus* Fitch.

Clastoptera proteus Fitch. Fitch, Asa. Homoptera, New York State Cab. Nat. Hist., p. 58; 1851.

Clastoptera proteus var. *flavicollis* Fitch Fitch, Asa Homoptera, New York State Cab. Nat. Hist., p. 58; 1851.

Clastoptera proteus var *maculicollis* Fitch. Fitch, Asa. Homoptera, New York State Cab. Nat. Hist., p. 58; 1851.

Clastoptera proteus var. *cincticollis* Fitch. Fitch, Asa. Homoptera, New York State Cab. Nat. Hist., p. 58; 1851.

Clastoptera proteus var. *seminuda* Ball. Ball, E. D. Can. Ent., vol. LIX, p. 108; 1927.

WRITER'S DESCRIPTION.

COLOR. Head yellow, vertex with an irregular black band on anterior margin, becoming wider at ocelli, eyes dark. Pronotum entirely yellow or marked in brownish-black in the form of a band on anterior margin, or one crossing the disc, or with one or two discoidal spots, or entire pronotum margined in brownish-black. Elytra, anterior two-thirds of clavus opaque bright yellow, corium at base tannish or very light brown, rest varying from pale hyaline to dark smoky, sometimes with a darker cloud across middle but never getting entirely black as in *nigricollis* and *osceola*, apical callous black. Face with a broad, shining black band across anterior half of postclypeus, and all of face below the antennal cavities, excepting the mandibular scletites or occasionally the genæ mottled; beak with last segment dark brown. Legs yellowish-white, with tarsus of anterior two pairs of legs washed in brown, a longitudinal dark stripe down femur and tibia, and with a dark ring around base of tibia. Hind legs yellowish, with last segment of tarsus and spines dark. Mesosternum yellow with touches of dark; metasternum and abdomen yellow mottled with dark, and in a few darker specimens almost black.

DISTRIBUTION. Doctor Ball states that "this species is common throughout the Northeastern states and eastern Canada, extending west to Montana and Northern Utah, where it is rare. The writer has not taken it in Colorado and California where much collecting has been done, rather indicating that it will not be found in the arid southwestern region outside of the higher mountains. It extends south to Florida and Texas, where it is again rare, probably owing to the hot summer. Forms from Hayti and Mexico seem to be varieties of this species."

Doctor Ball's statements refer to the species and its varieties together. The variety *proteus* is not very common as compared with the variety *nigricollis*. From the various collections in the hands of the writer only thirty-eight specimens of the former were found. The labels on these specimens showed that this variety has been taken in the following states: Iowa, Kansas, Massachusetts, Missouri, New York, South Dakota, Wisconsin and Ontario It apparently has the same distribution as *nigricollis*. In Kansas, where the majority of the thirty-eight specimens have been taken, it was always collected along with *nigricollis*.

All of these specimens at hand for study, as well as the Fitch types in Albany, were females.

LOCATION OF TYPES. Fitch collection, New York State Museum, Albany, N. Y.

HOSTS. In Kansas it is taken on dogwood. Fitch in his description states that it was abundant on the panicled dogwood (*Cornus paniculata*). Doctor Osborn (1916) referred to it as the "dogwood spittle bug."

Clastoptera proteus var. *nigricollis* Fitch.

Clastoptera proteus var *nigricollis* Fitch Fitch, Asa Homoptera, New York State Cab. Nat. Hist., p. 53; 1851.

Clastoptera proteé Fitch. (*Clastoptera saint-cyri*). Prov. Petite Faune du Entomologique, p 253; 1885.

Clastoptera proteus var *proteus* Fitch Van Duzee, E P Cat of Hemiptera, p. 519; 1917.

Clastoptera proteus Fitch. McAtee, W L Cercopidæ of the Vicinity of Washington, D. C., Proc. Ent. Soc. Wash , vol. 33, p 171, 1920

Clastoptera proteus var. *candens* McAtee. Cercopidæ of the Vicinity of Washington, D. C., Proc. Ent. Soc. Wash., vol 33, p 175; 1920

Clastoptera proteus var. *saint-cyri* Prov. Stearns, L. A Hemiptera Conn., p. 284; 1923.

Clastoptera proteus var. *flava* Ball. Ball, E. D. Can. Ent. LIX, p. 108; 1927

WRITER'S DESCRIPTION.

COLOR. A black, yellow and brownish variety. Front yellow, vertex bright yellow with a broad black band on anterior margin, reaching ocelli. Eyes brown or grayish-brown. Pronotum shining black with a bright yellow band on anterior portion. Scutellum usually entirely black, sometimes with a yellow spot at base, occasionally the entire scutellum yellow, margined with black. Elytra, anterior three-fourths of clavus opaque yellow, rest dark brown, fading to brownish-hyaline at apex, corium with a median dark brown or blackish cloud, rest brownish-hyaline except the black apical callous, which is margined in yellow and a clear hyaline area anterior to and surrounding the apical callous.

NOTES ON SYNONYMY.

McAtee (1920) established a variety of this form which he called *Clastoptera proteus* var. *candens*. The following is the original description of the variety:

> "Like var. *proteus,* except that anterior two-thirds of clavus, scutellum, bands on pronotum and vertex and face are orange-red, instead of yellow, and other pale markings are ruddy-tinged. Length 3.25 to 4 mm. Type, a female. Mt. Vernon, Va., June 27, 1915, on *Cornus*. W. L. McAtee. Two paratypes, same data."

To the writer this does not seem to be a good variety. As McAtee himself says, certain climatic conditions may effect the yellow pigment of this species. He gives the following discussion:

> "The high color of these specimens is not due to the influence of cyanide in the killing bottle, such as is sometimes observed in specimens of bees in the genus *Nomada* and certain other insects, but was noted at the time of collection. Certain animal pigments seem to be quite unstable, and the yellow of *Clastoptera proteus* may be another instance. Crawfishes turn red after cooking, digestion in a bird's stomach, or weathering after death; and one of the species of southern range (*Cambarus clarkii*) is bright red in life. Some of the Eumenidæ having yellow marks in the north are red-patterned in the south. It would appear, therefore, that climatic factors affect certain pigments of living animals in the same way that chemical processes are known to affect them in the dead. The present newly described variety of *C. proteus* may be an example of such effect."

Doctor Ball states that this variety has been taken only from Virginia. Specimens from New Jersey are in the American Museum collection. Also one specimen has been taken from Michigan and one from Kansas. The first of these is orange on one elytron only. This would lead one to infer that this coloring is not constant enough to establish a new variety. Besides, the writer has found three specimens of *Clastoptera salicis* where the yellow has turned orange, and several other specimens where the legs and parts of body are tinged with orange, particularly on the under side of body.

DISTRIBUTION. The variety *nigricollis* seems to have a very wide distribution, as mentioned by Doctor Ball under his discussion of the species. The writer had on hand for study specimens from the following states: California, Ontario, Colorado, Connecticut, Illinois, Iowa, Kansas, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New York, Ohio, Pennsylvania, South Dakota and Wisconsin. It has been reported from the following additional states: Florida, Maine, Montana, New Hampshire, North Carolina, Texas, Utah and West Virginia

The proportion of males and females is approximately equal, with perhaps a few more females than males.

LOCATION OF TYPES. Fitch collection, Albany State Museum, Albany, N. Y.

HOSTS. This, like the variety *proteus,* has been taken on dogwood. Specimens in the National Museum collection have been taken from the Arnold arboretum, Boston, Mass., and were swept from *Vaccinum* spp., *Cornus albus* *rosenthalii, Cornus racemosus,* and *Cornus amœmum.* Van Duzee reported it from blueberry.

Clastoptera proteus var. *osceola* Ball.

Ball, E. D. Can. Ent., vol. 58, p. 108; 1927.

ORIGINAL DESCRIPTION.

All black above, except the three anterior yellow bands, a spot on scutellum, a yellow area at the base of elytron, and a light area before the bulla. In the darkest examples only the two anterior yellow bands remain.

Holotype female, Toronto, August 8, 1924; allotype male, Kingston, August 5, 1924; and three pairs of paratypes from the same localities and Osceola, Wis., all collected by the author.

WRITER'S DESCRIPTION.

COLOR. Mostly a black form with yellow and brownish markings. Front yellow, vertex with a broad black band on anterior margin, reaching ocelli. Eyes brown. Pronotum shining black, except for a bright yellow band across anterior portion. Scutellum all black. Elytra, usually with anterior three-fourths of clavus and a broad median cloud black or dark blackish-brown, sometimes a faint indication of yellow at base of clavus, rest of elytron brownish-hyaline, excepting for the costal cell between apical callous and black area which is clear hyaline. Apical callous black, margined anteriorly with yellow. Face with a broad, shining black band across anterior half of postclypeus, and all of face below the antennal cavities black excepting the mandibular sclerites, or occasionally the genæ mottled. Legs yellowish-white, with tarsus of anterior two pairs of legs washed in brown, a longitudinal dark stripe down femur and tibia and with a dark ring around base of tibia. Hind legs yellowish with last segment of tarsus and spines dark. Mesosternum brown. Metasternum yellow and abdomen usually black.

COMPARATIVE NOTES. This variety differs from the var. *nigricollis* in that it has at most but a faint suggestion of yellow at base of clavus, and usually none. It more nearly resembles *C. saint-syri* var. *anceps* than it does var. *nigricollis,* since the former is likewise an almost entirely black form. It can be distinguished readily enough from the variety *anceps,* however, both by color and structure. The latter bears no yellow markings at all on its dorsal surface, while *osceola* has two or three anterior yellow bands on vertex and pronotum. Structurally the two species differ in the following respects: In *anceps* the female specimens, at least, have the front much more inflated, the front more strongly produced anteriorly beyond vertex and head, and anterior part of prothorax held more vertically than in *osceola.* Moreover, *anceps* is a shorter, stouter species than *osceola.* In *osceola* the black band on the face is only one-half the length of the postclypeus, while in *anceps* it is always two-thirds of the length. The ovipositors differ in the following respects: In *anceps* the ninth sternite is longer proportionately to the lateral valve, and the lateral valves do not extend beyond the pygofer nearly as much as in *osceola;* while the dorsal valve is much broader and shorter, the notches are more pronounced and the teeth are more numerous, regular and deeper in the former than in the latter. The base of the ventral valve is expanded in *anceps,* but decidedly narrowed in *osceola.*

Clastoptera proteus var. *osceola* might easily be confused with *Clastoptera hyperici*, which is also a black form. It differs from this species in the following ways: *Hyperici* has an ovate body, tapering at both ends equally, and is widest directly through the middle, while *osceola* is widest caudad of the middle from whence it abruptly tapers to apex, thus making the body rather pear-shaped. The easiest recognizable difference, however, is the color of the elytra; *osceola* has the apical portion all brownish-hyaline with a clear hyaline spot surrounding the apical callous, while *hyperici* is almost a solid black or very dark brown, with the exception perhaps of the membrane, which is only a trifle lighter and clearer than the rest of the elytron. The ocelli of *osceola* are located closer together than in *hyperici*, the distance between the ocelli in *osceola* equaling about one-half the distance between each ocellus and eye, while in *hyperici* the space between the ocelli is about three-fourths the latter distance. The front (tylus) in *hyperici* extends cephalad much farther than in *osceola*, usually as much as length of vertex, while in the latter it protrudes only about one-half the width of vertex. The clypeus of *hyperici* is likewise much more inflated than that of *osceola*. Another outstanding difference is that the elytra of *hyperici* are covered by twice as many hairs as in *osceola* or *anceps* and the hairs are of a much finer and longer texture. In *hyperici* the lateral valve of the ovipositor is shorter and decidedly more bluntly rounded, the ninth sternite is about two-thirds the length of the valve instead of being one-half as in the latter, and the inner valve is much wider and shorter. Also, this inner valve in *hyperici* entirely lacks the second prominent notch found on the inner margin of the valve, and the basal notch is not nearly as prominent as in *osceola*. The teeth of this valve in *hyperici* are very fine and regular, numbering approximately 110, while in *osceola* they are more irregular and number around 80. The middle valve of *osceola* is narrowed considerably at base, which condition is not found in *hyperici*. The male genitalia of *hyperici* has the lateral hook much longer in proportion to apical hook than in *osceola*. For comparison with *xanthocephala* see discussion under the description of *xanthocephala* on page 76.

DISTRIBUTION. The variety *osceola* seems to have a more limited distribution than *nigricollis*. The type locality, according to Doctor Ball, is Canada and Wisconsin. In the Snow collection at the University of Kansas there are some thirty-eight specimens all taken from Michigan and Wisconsin. In other collections a few specimens are labeled from New York, New Jersey and Massachusetts. Therefore this variety seems to be limited in its distribution to the Northeast.

LOCATION OF TYPES. Collection of Dr. E. D. Ball, Sanford, Fla.

HOSTS. This variety has been taken along with the variety *nigricollis*, so its chief host plant is dogwood. One specimen in the National Museum collection bears a label stating that it has been taken from the Arnold arboretum, Boston, Mass., on *Vaccinum* sp.

Clastoptera saint-cyri Provancher.

(Plates III, V, IX, XIII, XVII, XXI, XXIV, XXV.)

Clastoptera saint-cyri Prov. Provancher, Nat. Can. IV, p. 351; 1872.

ORIGINAL DESCRIPTION.

Clastoptera saint-cyri nov. spec.—Longeur, 18 poucé. Varié de jaune et de noir. Tête noire avec 2 bandes transversales jaunes, l'une aur le vertex et l'autre rapprochée du bord antérieur. Rostre et bas des joues jaunes: thorax noir, avec une bande transversale jáune près du bord antérieur. Elytres avec 2 bandes jaunes partant de l'épaule et se dirigeant obliquement vers la suture, sans se rencontrer; leur sommet brunâtre, assez transparent, avec un point noir brillant vers l'extremité. Dessous noir; pattes jaunes.

Trés common. Trés rapproché du *Cl. pini* de Fitch par sa taille et sa forme, mais en différant grandement par sa coloration.

Thus Provancher described this species in 1872 as a new species. Then in a second paper, published in 1885, he wrote a description of Fitch's *proteus* wherein he mentions the clavus being yellow at base and darker at apex, and accompanies his description with an illustration. There is no doubt but the form he had in mind was *C. proteus* var. *nigricollis* of Fitch. In this latter paper he states that his species *saint-cyri* is a synonym of Fitch's *proteus* and makes it a variety of *proteus* instead.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 3.45 mm. to 3.9 mm. Width: ♀ 2.25 mm. to 2.62 mm.

SHAPE. A short, broad species, apparently the most globose and inflated of the *Clastoptera* series, with head and thorax more vertical when viewed from the side than in other species.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin not distinctly carinated. Front (tylus) usually produced cephalad as much as the length of the vertex. Eyes with length about one-fifth of total width of head. Ocelli located halfway between anterior and posterior margins of vertex with the space between them a little over one-half the distance between each ocellus and eye. Postclypeus very strongly inflated, length about one and three-fourths times length of anteclypeus, width somewhat wider than combined width of gena and eye. Pronotum bare and shining, broadly and shallowly wrinkled, with wrinkles sometimes barely distinguishable, numbering about 16 or 17, anterior margin rounding, posterior margin deeply emarginate and lateral margins diverging; head and anterior part of prothorax when viewed from side more vertical. Elytra, length of one about two and one-fourth times its width, narrow at base, then lateral margins diverging so that widest part of body is just cephalad of a line drawn from apex of clavus to costal margin, from which point they abruptly round to apex; their surface covered by relatively few hairs, slightly more than in *proteus* but fewer than in *hyperici* or *salicis*. Wing venation, cell R_5 of elytron slightly wider than long or almost equal, cell R_8 shorter than first M_4, darkened portion of apical callous round and comparatively small, not reaching costal margin, but with rest of cell R_1 sometimes thickened.

External genitalia: Pygofer trifle wider than long, exceeded by ovipositor one-fifth of its length, ninth sternite almost two-thirds length of valve. Male genital plates broad at base, inner margins separated approximately three-fourths of their length and rounding to a blunt apex, styles exposed about one-fourth length of plates.

Internal genitalia: Lateral valve of ovipositor roundingly pointed, decidedly shorter and broader than in *proteus;* inner valve with basal part of inner margins united and free apical portions bearing fine, deeply notched teeth, numbering around 108, and with two well-pronounced notches, one located at point of union of the two valves and the other at base of apical third; inner valve bladelike, not much narrower at base and tapering to a pointed apex. Styles of male broad and stout, base extended into a flap, apical fifth at base bearing laterally a recurved hook, from whence it tapers to a long dorsad-curving, sharply pointed apex; connective, roughly triangular, twice wider than long, œdagus a straight rod with a rounded apex, which is always more or less curved dorsad.

Clastoptera saint-cyri var. *saint-cyri* Provancher.

Clastoptera saint-cyri Prov. Provancher. Nat Can. IV, p. 851; 1872.
Clastoptera proteus var. *vittata* Ball. Ball, E D. Proc. Ia. Acad. Sci. III, p. 187; 1895.
Clastoptera proteus var. *vittata* Ball. Van Duzee, E. P. Catalogue of Hemip.; 1917.
Clastoptera proteus var. *vittata* Ball. Stearns, L. A. Hemip. Conn., p. 284; 1923.
Clastoptera proteus var. *saint-cyri* Prov. Ball, E. D Can Ent. LIX, p. 107; 1927.

WRITER'S DESCRIPTION.

COLOR. Dark brown or black, marked with yellow. Vertex with anterior black border, reaching ocelli, the rest yellow. Pronotum black with black anterior margin followed by a yellow band of varying width, extending to base of eyes or sometimes a second broad yellow band caudad to first one, which may be reduced to a spot or enlarged so as to occupy the posterior part of pronotum in varying degrees. Scutellum usually black with a yellow spot on apex, or occasionally all black. Elytra blackish-brown and yellow, clavus appearing striped, due to two yellow diverging bands which start together at base, the inner extending three-fourths the length of the clavus, leaving a narrow black border along the elytral margin, and the outer extending along the claval suture, often posteriorly divided by a black line, the apex of clavus brownish-hyaline, corium dark brown with the explanate costal margin brownish-hyaline, a jagged oblique yellow band across middle, and the apical third brownish-hyaline with the exception of the costal cell anterior to the apical callous which is hyaline, and the apical callous itself which is black surrounded by yellow. Face with a a shining black band extending caudad for three-fifths the length of the postclypeus, and dorsad on front for at least half its length, making the yellow band at base of front which is viewed from above only half as wide as in the other members of this *proteus* group, the anterior margin of black band almost straight across to the posterior corners of the mandibular sclerites instead of being strongly convex between these points as in *proteus;* genæ all black excepting the mandibular sclerites; anteclypeus yellow with a dark spot in center. Legs pale yellow, excepting a longitudinal streak on anterior two pairs of femora, and tibiæ and tarsi black. Hind legs entirely yellow, with the exception of the last tarsal segments and spines on tibiæ and tarsi, which are dark brown or black. Mesosternum dark brown. Metasternum yellow. Abdomen brown or black.

COMPARATIVE NOTES. See notes under this heading in the description of *Clastoptera salicis.*

DISTRIBUTION. A large series has been taken in Michigan. Provancher says it is very common in Canada. Other states in which it has been taken are Connecticut, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania and Wisconsin.

One hundred and thirty-two specimens were available for study, all of which were females.

HOSTS. Doctor Hungerford states that this variety has been taken in Michigan, sweeping the same low vegetation on which *anceps* is taken. In the National Museum collection are specimens from Boston, Mass., which bear the same data on their labels as some specimens of *Clastoptera proteus* var. *osceola* and var. *nigricollis.* One specimen was taken from *Vaccinum* sp., one from shrub collection, one from *Leucothce* sp. and one swept from *Gyluscacia* sp. Another set of eight was labeled "Reared from Cranberry." Six of these were striped *saint-cyri* females and two were black males of the typical *anceps* type. These eight are mounted on two cards, on one four females and on the other two females and two black males.

Clastoptera saint-cyri var. *anceps* McAtee.

(Plates III, V, IX, XIII, XVII, XXI, XXIV, XXV.)

Clastoptera proteus var. *anceps* McAtee. McAtee, W L. Cercopidæ of the Vicinity of Washington, D. C, with Descriptions of New Varieties of *Clastoptera* Proc. Bio. Soc. of Wash. 33, p 174; 1920

Clastoptera proteus subsp *nigra* var. *b* Ball. Ball, E. D. Proc. Ia Acad. Sci. III, p. 187; 1895.

Clastoptera proteus var. *pini* Fitch Stearns, L A Hemiptera of Conn.; 1923.

Clastoptera proteus var. *anceps* McAtee. Ball, E. D Can Ent. LIX, p. 109; 1927.

According to McAtee and Van Duzee the name *nigra* is preoccupied by *Clastoptera nigra* Germar. Therefore Doctor Ball's original varietal name cannot stand. This species is not synonymous in the least with *Clastoptera pini,* as Van Duzee and Stearns both thought. A new name was therefore necessary, which was supplied by McAtee (1920). McAtee, however, placed it as a variety of *proteus.* Structurally it differs from *proteus,* but resembles *saint-cyri,* so that it must be placed as a variety of the latter.

Ball (1927) lists his variety *nigra* as being synonymous with *hyperici.* According to his original description (1895) it seems evident that his var. *a* was the same as *C. proteus* var. *osceola* because of the yellow band on vertex, while his variety *b* probably referred to *anceps.* Specimens which he sent to the writer for study labeled *nigra* were typical forms of the variety *anceps.*

ORIGINAL DESCRIPTION.

Black above, tegmina posterior of apical callous yellowish-hyaline, explanate margin anterior of middle of costa sometimes same color; costal margin just anterior of apical callous clear hyaline; black below, except lower part of face, clypeus, beak, most of pectus, and legs which are pale yellow, with the following parts dark; an elliptical spot on clypeus, tip of beak, lengthwise streaks on anterior two pairs of femora, and tibiæ and tarsi except the hind ones, of which the spines and terminal joints are dark. Length 2.75 to 3.25 mm. Type, a male; Beltsville, Md., June 14, 1914, W. L. McAtee. Paratypes, with same data, also same locality, July 4, 1915, W. L. McAtee; and Cranberry Lake, N. Y., August 5, 1917, C. J. Drake.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 3.75 mm. to 4.05 mm.; ♂ 2.75 mm. to 3.6 mm. Width: ♀ 2.55 mm. to 2.85 mm.; ♂ 1.8 mm. to 2.25 mm.

COLOR. All black and brown above, front and vertex shining dark brown or all black. Eyes light to dark brown. Pronotum shining black. Scutellum all black. Elytra with anterior three-fourths of clavus and a median large spot across corium pitch black, rest of wing brownish-hyaline except for the costal cell between apical callous and the black spot, which is clear hyaline. Apical callous black margined anteriorly with yellow. Face, postclypeus with a shining black band on anterior three-fifths or two-thirds, rest of face black excepting mandibular sclerites and anteclypeus, the latter with a central black spot, labium dark at tip. First two pairs of legs yellow except for a longitudinal brown stripe on femur and tibia, the latter with a dark spot running into the longitudinal stripe, the tarsus entirely brown. Hind legs all yellow, excepting last tarsal segment and spines which are dark brown or black. Mesosternum, excepting median portion and abdomen, black.

COMPARATIVE NOTES. *C. proteus* var. *anceps* may be easily mistaken for any of the other dark species found in the genus. For comparison with *C. proteus* var. *osceola,* which it closely resembles, see discussion on page 43.

Likewise it resembles *C. hyperici* very closely, but can readily be distinguished by the following characteristics: The body of *hyperici* is more oval in shape than *anceps* is, tapering at both ends equally and widest directly through middle of body, while in *anceps* the body is widest posterior to middle or just anterior to a line running from tip of clavus to costal margin. Also *anceps* is proportionately broader than *hyperici.* The easiest recognizable difference, however, is the color of the elytra; *anceps* has the apical portion all brownish-hyaline with a clear hyaline spot anterior to apical callous, while *hyperici* is almost a solid black or very dark brown, with the exception, perhaps, of the membrane, which is only a trifle lighter and clearer. The ocelli are located closer together than in *hyperici,* the distance between the ocelli in *anceps* equaling about one-half the distance between each ocellus and eye while in *hyperici* the space between the ocelli is about three-fourths the latter distance. Another outstanding difference is that the elytra of *hyperici* bear about twice as many hairs as do those of *anceps* and are longer and of a much finer texture. The lateral valve of the oviposter of *hyperici* is much shorter and decidedly more bluntly rounded than the other. The dorsal valve is shorter and therefore wider in *hyperici,* and only bears a faint indication of one notch at point of union of inner margins of the valves, while *anceps* bears two very distinct notches. The teeth of this valve are equal in number, namely, about 110, with those of *anceps,* but since the valve is much shorter and smaller they appear to be more numerous, and in actual width are about half the size of the teeth in *anceps*. The male genitalia are very similar, the chief difference being that the base of the apical hook in *anceps* seems to be somewhat more slender than that of *hyperici*.

For the comparison with *C. binotata* and *C. sierra*, see the discussion on page 31, and for comparison with the males of *C. brunnea*, *C. lineatocollis*, see the discussion on page 23. For comparison with *xanthocephala*, see the discussion in the description of the latter, on page 76.

DISTRIBUTION. Specimens have been taken from Maine, Maryland, Massachusetts, Michigan, Montreal, New Jersey, New Hampshire, New York, Rhode Island, Washington, D. C., and Wisconsin. A large series was obtained by Dr. H. B. Hungerford, Mr. Charles Martin and Mr. Edward Becten from Douglas Lake, Mich.

Approximately 188 specimens were examined. Of this number only 63 were females and 112 were males.

LOCATION OF TYPES. In the collection of the National Museum, Washington, D. C.

HOST PLANTS. Doctor Hungerford took this species in Michigan when sweeping low vegetation. It was taken along with *saint-cyri*. In distribution they appear to be about equal in number to the latter, although *anceps*, perhaps, is a trifle more abundant than *saint-cyri*. *Anceps* has also been taken, according to labels, at Boston, Mass., in the Arnold arboretum, apparently along with *saint-cyri*, *nigricollis* and *osceola* on *Vaccinum* sp. Specimens of this variety have also been taken at Mount Desert, Me., along with *saint-cyri*.

Clastoptera salicis Doering

(Plates III, V, IX, XIII, XVII, XXI, XXIV, XXV.)

Clastoptera salicis Doering. Doering, K. C. Ann. Ent. Soc. Am. 19, p. 85. 1926.
Clastoptera proteus var. *salicis* Doering. Ball, E. D. Can. Ent. LIX, p. 107, 1927.

ORIGINAL DESCRIPTION

SIZE. Length ♀ 4.4 mm. to 5.2 mm., ♂ 4 mm. Width ♀ 2.4 mm. to 2.8 mm., ♂ 2.4 mm.

SHAPE. An elongate, slender form, in size equaling some of the larger forms in the genus.

COLOR. Dark brown or black, and conspicuously marked with yellow. Vertex with anterior black border, reaching ocelli, the rest yellow. Face, anterior third or two-fifths of postclypeus and all of genæ black the rest of the face yellow, labium dark at tip. Pronotum black, with black anterior margin followed by a yellow band which extends to the bases of the eyes, and with a second yellow band on posterior half, which may be reduced to just a spot or be entirely lacking. Scutellum, usually entirely black or brownish-black, but frequently with apex light yellow or occasionally a light longitudinal band extending along median line, which sometimes broadens just in front of middle into two light spots. Elytra blackish-brown and yellow, clavus appearing striped, due to two yellow bands which start together at base, the one extending one-half to almost two-thirds the length of the clavus, leaving a narrow black border along the elytra margin, and the other extending along the claval suture almost to the tip; corium dark brown, spotted with yellow as follows: A small longitudinal spot at base of costal margin; a large rounded or rectangular one about midway on costal margin, and just caudad of this but near the claval suture a longer, somewhat trapesoidal or triangular one; apical callous surrounded by yellow with a large spot cephalad, tapering to a point anteriorly, usually a line near costal margin, extending near apical callous to a large brown spot near middle of costa, the cell between apical callous and this spot being hyaline, and another small, hyaline area, usually showing in the yellow spot, cephalad of apical callous. Coxa, trochanter, and femur of first two pairs of legs yellow, washed in orange or light brown, tibia and tarsi black, with sometimes a yellow band or mark at base of tibia. Hind legs entirely yellow, with the exception of the last two tarsal segments and spines on tibiæ and tarsi, which are black or dark brown. Mesosternum brown or black; metasternum yellow. Abdomen brown or black, sometimes posterior margins of segments lighter.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin not distinctly carinated. Each eye slightly over one-fifth width of head. Ocelli located slightly nearer anterior margin of vertex than pronotum, and distance between the two ocelli about three-fourths the distance between each ocellus and eye. Postclypeus not as strongly inflated as *proteus* or *saint-cyri*, indistinguishably fused with front, which is prolonged anteriorly beyond vertex for about two-thirds length of latter, being somewhat longer in the female than in the male; postclypeus much longer proportionately than anteclypeus, at least twice, labium reaching to trochanter of middle pair of legs, postclypeus wider than gena and eye. Pronotum finely wrinkled, wrinkles numbering at least twenty-one or twenty-two, posteriorly more broken and numerous and somewhat deeper, cephalic margin produced and a trifle more angulate, posterior margin deeply emarginate, about half width of anterior margin, lateral margins slightly sinuate Elytra approximately two and three-fourths times as long as wide, base of costal margin flaring, then parallel-margined to apical third of elytron, from whence it abruptly incurves to rounded apex, with no point along costal margin wider than any other and with elytra only slightly inflated, covered thickly by long, fine hairs. Wing venation, cell R_5 much longer than wide, cell R_3 shorter than cell first M_4, apical callous large, oval or elongate, taking up most of cell R_1.

External genitalia: Pygofer, length equal to width, exceeded by ovipositor about one-fourth its length, the ninth sternite longer than one-half length of lateral valve; male genital plates broad at base, inner margins rounding to a blunt apex, exceeded by genital styles only slightly.

Internal genitalia: Lateral valve tapering to a very pointed apex, inner valve united on inner margins for half their length, their free apical inner margins slightly and irregularly jagged, bearing two notches, one at point of union of the two valves and the other at base of apical fourth; middle valve, with base expanded, then slightly narrowed, from whence it broadens slightly and then tapers to a pointed apex. Male styles broad and stout, base extended into a flap, apical fourth at base bearing laterally a recurved hook, from whence it tapers to a slender dorsad-curving sharply-pointed apex; connective roughly triangular, twice wider than long, œdagus a straight rod with a rounded apex.

COMPARATIVE NOTES. *Clastoptera salicis* can easily be told from any other member of the *proteus* group by its coloration and large size, being at least one-fourth longer than the others. In color pattern the only one that possibly might be confused with it is *Clastoptera saint-cyri* var. *saint-cyri*, since both of these forms have the clavus of the wings striped with black and yellow. However, size alone would distinguish these two, as well as the following structural differences: Front of *salicis* only extends anteriorly about two-thirds length of vertex, while in *saint-cyri* the lengths are equal. The face of *salicis* is considerably less inflated and the length of the postclypeus is much longer proportionately than that of *saint-cyri*, being in the former twice the length of the anteclypeus, while in the latter not over one and three-fourths the length of anteclypeus. The wrinkles on the pronotum are more numerous and deeper than in *saint-cyri*. The elytra are scarcely inflated and the margins are parallel, which is distinctly different from *saint-cyri*, where the elytra are greatly inflated, and the margins diverge so that the wide part of the body is just anterior to a line across to apex of clavus. *Salicis*, in this characteristic, is between *Clastoptera xanthocephala* and *Clastoptera hyperici*, and therefore does not resemble the *proteus* group at all. The wing venation is perhaps the best character for distinguishing *salicis* from any of the *proteus* group; cell R_5 is much longer than wide in this species, while in all the others it is just the opposite, being usually wider than long, or equal in width and length. Also the apical callous in *salicis* is much larger, occupying much more of cell R_1 than it does in *saint-cyri*. The hairs on the elytra are about twice the number they are on *saint-cyri* and the *proteus* group. *Salicis* resembles *hyperici* in this respect. The ovipositor extends one-fourth of its length beyond pygofer while in *saint-cyri* it extends about one-fifth of its length. Still another difference has to do with the inner margins of the inner valves of the ovipositor, which are irregularly jagged but not distinctly toothed in *salicis*, but which bear regular, distinct teeth in *saint-cyri*, numbering about one hundred and eight. Moreover, although the coloration of the face in this form seems to be that of the *proteus* group, namely, the black band on anterior part of face with lower part of postclypeus, anteclypeus and mandibular sclerites yellow in sharp contrast, yet this yellow band in *salicis* is characteristically less than in the other members of the *proteus* group, and particularly *saint-cyri*. In *salicis* the band is typically two-fifths or one-third of the length of the postclypeus, while in *saint-cyri* it is always over one-half, usually nearer three-fifths. Occasionally a few specimens of *salicis* show the band almost one-half the length of the postclypeus, but upon examination of sixty specimens the majority were found to have a band which was less than one-half. Besides in *saint-cyri* and the var. *anceps* the black band extends dorsad on the front, but does not do this in *salicis* or *proteus*.

Doctor Ball places *salicis* as a variety of *proteus*, for which the writer sees no justification at all. Outwardly there is no resemblance, the larger size and color pattern of *salicis* distinguishing it immediately. The only reasons for confusing it with any of the *proteus* group are because of the color of the face and the similarity of the male genitalia. The color of the face, although one of the causes for placing *salicis* with *proteus* and its varieties, at the same time proves to be a good characteristic for distinguishing *salicis* from the other members of the group. As was mentioned before, the anterior black band on the face in *salicis* is usually not as wide as the bands in the other members of this group. In *saint-cyri* this band is three-fifths of the postclypeus, in *enceps* and *hyperici* two-thirds, and in *proteus* always one-half.

Structurally *salicis* differs from *proteus* in a number of ways. The face of *salicis* is less inflated than that of *proteus* (figs. 5 and 6, pl. III). The wrinkles on the pronotum are more numerous and slightly deeper. The elytra are scarcely inflated in *salicis*, while in *proteus* they are considerably inflated, and their margins are parallel in the former but diverge in the latter. The pubescence on the elytra of *salicis* is about twice as heavy as on *proteus*. The outstanding characteristic is that cell R_5 of *salicis* is considerably longer than wide, but in *proteus* it is slightly wider than long. The apical callous of *salicis* is much larger and more ovate, occupying most of cell R_1, while in *proteus* it is round and small. The ovipositor extends beyond the pygofer about one-fourth of its length instead of one-third as in *proteus*. Then, too, the ninth sternite is longer than one-half the length of the lateral valve, while in *proteus* it is about one-half. The inner margins of the inner valves of the ovipositor bear two distinct notches as in *saint-cyri*, while in *proteus* the first notch is lacking or only faintly indicated. Moreover, these margins in *salicis* are irregularly jagged but not cut deep enough to form distinct teeth, while in *proteus* they bear distinct teeth. The male genitalia are twice the size of either *saint-cyri* or *proteus*, a fact which alone would distinguish this species from the latter two. The apical hook on the genitalia seems more slender than that of *proteus*, and the lateral hook is much longer in proportion to the apical hook, while the style itself is not as broad proportionally as in *proteus*

DISTRIBUTION. A series of some seventy specimens have been collected from four counties in Kansas and one other specimen from Missouri. In this series only three were males, which shows that the males are exceedingly rare.

LOCATION OF TYPES. Holotype and allotype are located in the Snow collection, University of Kansas.

HOST PLANTS. This species has been taken on two species of willow, *Salix amygdaloides* Anders., the broad-leaved willow, and *Salix longifolia* Muhl., the narrow-leaved willow, both of which border rivers.

Clastoptera hyperici Gibson.

(Plates III, V, IX, XIII, XVII, XXI, XXIV, XXV.)

Clastoptera proteus var. *hyperici* Gib. McAtee, W. L. Proc. Bio. Soc. Wash., vol. 33, p. 174; 1920.

Clastoptera proteus var. *hyperici* McAtee (Gib.) Ball, E. D. Can. Ent. LIX, p. 109; 1927.

ORIGINAL DESCRIPTION.

Agreeing with *proteus* var. *proteus* in inflation of face, shape of vertex, striæ of pronotum and genitalia, but entirely black above and below, also with the exceptions of the lower part of the face, clypeus, most of pectus, posterior two pairs of coxæ, two spots, or an interrupted stripe on lower surface of each of the anterior two pairs of tibiæ, a spot on anterior surface near apex of each femur sometimes excepted, apices of hind tibiæ except spurs, and hind tarsi except spurs and last joint, pale yellow. Length, 2.5 to 3.5 mm. Type, a male, Plummers Is. Md., July 5, 1914, on *Hypericum prolificum*, W. L. McAtee, allotype same data. Paratypes, same data, also same data except as to dates, July 14 and 26, 1914, and same locality August 11, 1907, W. L. McAtee.

This variety has been seen also at Great Falls and at Occoquan, Va., in each case upon the same food plant, being most abundant during the flowering season.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 3.5 mm.; ♂ 3.15 mm. Width: ♀ 2.25 mm.; ♂ 2.1 mm.

SHAPE. An ovate, small species, tapering posteriorly and anteriorly almost equally with the greatest width of body directly across middle.

COLOR. Almost uniformly black above with the exception of the apical portion of corium and membrane which is slightly lighter in color. Postclypeus with a black band across anterior two-thirds, rest of face black, excepting mandibular sclerites and anteclypeus, which are yellow, the latter with a dark spot at center. Labium dark. First two pairs of legs with coxa mottled in yellow and brown, femur black but usually with a yellow spot on anterior surface near apex, tibia black excepting two yellow spots or interrupted stripe on lower surface. Hind legs black with apices of tibia, and first two segments of tarsus light. Mesosternum black; metasternum either all yellow or black with the median portion light Abdomen entirely black.

STRUCTURAL CHARACTERISTICS Vertex slightly depressed transversely, anterior margin not distinctly carinated. Front prolonged anteriorly as much as the length of the vertex Greatest length of eye about equal to one-fifth total width of head. Ocelli, located halfway between anterior and posterior margins of vertex, with the space between them almost three-fourths the distance between each ocellus and eye Postclypeus very strongly inflated, length about one and three-fourths times length of anteclypeus, width somewhat wider than combined width of gena and eye Pronotum bare and shining, broadly and shallowly wrinkled, with anterior wrinkles sometimes indistinguishable and numbering about seventeen or twenty, anterior margin rounding, posterior margin deeply emarginate and lateral margins diverging. Elytra, length of one, about twice width, narrowed at base, then margins evenly sinuate to apex, so that body is widest across the middle; surface covered by many long, fine hairs. Wing venation, cell R_5 of forewing wider than long, apical callous not distinct, being same color as rest of elytron, only slightly raised, occupying nearly all of cell R_1.

External genitalia: Pygofer of female, length about equal to width, exceeded by ovipositor by over one-third its length, ninth sternite two-thirds length of lateral valve. Male genital plates broad at base, inner margins separated for part of their length, rounding to a blunt apex, the styles exposed only slightly beyond valves.

Internal genitalia: Lateral valve of ovipositor bluntly rounded at apex; inner valve with basal part of inner margins united, and free apical portions bearing fine teeth, numbering around 110, and a small notch at point of union of the two valves; inner valve bladelike, not narrowed at base and tapering to a pointed apex. Styles of the male broad and stout, base extended into a flap, and base of apical fifth, bearing laterally a recurved hook, after which it tapers to a long dorsad-curving, sharply pointed apex; connective roughly triangular, twice wider than long, œdagus a straight rod with rounded apex which is curved dorsad.

COMPARATIVE NOTES. This species, being an entirely or almost entirely black form, is apt to be confused with the other black forms in the genus. For comparison with *C. binotata,* see page 32, with *sierra,* see page 34, with the males of *brunnea* and *lineatocollis,* page 23, and with *xanthocephala,* page 76. In the *proteus* group it very closely resembles *C. proteus* var. *osceola* and *C. saint-cyri* var. *anceps.* For comparison with these forms see pages 44 and 48.

DISTRIBUTION. Only five specimens were available for study. These were sent to the writer for study by Mr. McAtee and were all collected from Plummer's Island, Md.

LOCATION OF TYPES. The types are in the collection of W. L. McAtee, Washington, D. C.

HOST PLANTS. Taken on *Hypericum prolificum* (St. John's Wort).

Clastoptera distincta sp. new.

(Plates III, V, IX, XIII, XVII, XXI, XXIV, XXV.)

SIZE. Length: ♀ 4.65 mm. to 5.02 mm.; ♂ 4.35 mm. to 4.5 mm. Width: ♀ 2.62 mm. to 2.7 mm.; ♂ 2.4 mm. to 2.47 mm.

SHAPE. An elongate species with a pointed head and body decidedly tapering to a slender apex posteriorly, resembling *osborni* in shape more than any other species.

COLOR. A striking chocolate-brown and yellowish-green species. Front and vertex greenish-yellow, the lateral margins of both shaded in brown and with three pairs of brownish arcs visible from above on front. Face, postclypeus yellow with nine or ten pairs of distinct brown arcs, the posterior three or four pairs usually more or less fused together to form an irregular dark band, lower two-fifths of postclypeus, all of anteclypeus excepting a median dark spot and mandibular sclerites all yellow, the latter sometimes washed through center with fuscous; genæ dark brown with margins, and especially anterior portions, much lighter. Pronotum entirely greenish-yellow, with lateral margins washed in brown. Scutellum chocolate-brown except for the light yellow apex. Elytra, clavus entirely dark chocolate-brown; corium also this color, except for the golden-brown explanate costal margin, the lighter brown membrane and a golden or yellow spot just cephalad of apical callous which extends forward on costal margin for a short distance, the entire elytron covered by a golden pubescence. Legs, first two pairs with coxa, trochanter, and femur very dark, except for extreme yellow bases and apices; tibia dark with two light spots on cephalic surface, tarsus dark brown with blackish-brown claws. Hind legs lighter, mottled in dark brown, with tips of spines and tarsal claws black. Mesothorax dark brown. Metathorax brown anteriorly and yellow posteriorly. Abdomen of female yellowish with pygofer dark brown; male abdomen dark brownish-black.

STRUCTURAL DETAILS. Vertex not depressed transversely, anterior margin faintly carinated. Length of one eye over one-fourth total width of head. Ocelli located slightly closer to anterior margin of vertex than pronotum, the distance between the two ocelli a little less than distance between each ocellus and eye. Front greatly extended beyond vertex, as much as the length of the latter, the head decidedly pointed. Pronotum about twice as wide as long, the anterior margin roundingly angulate, lateral margins subparallel, posterior margin deeply emarginate, the entire surface broken up by numerous fine, irregular wrinkles, resembling those of *osborni*. Scutellum, width three-fifths of length. Elytra, long and narrow, each wing over three times its width, the distance from apex of scutellum to apex of elytron longer in proportion to rest of elytron, thus resembling *osborni* and differing from the other species, the costal margin greatly expanded at base, the outer margins flaring, then parallel-margined for a short distance, from whence they converge to a slender apex, the widest part of body being at a point midway across wing. Wing venation, cell R_5 much longer than wide, cell R_3 smaller than cell first M_4, apical callous large and bulbous, occupying all of cell R_1.

External genitalia: Pygofer of female, length and width about equal, exceeded by ovipositor about one-seventh the length of the latter. Male pygofer wider than long, genital plates broad at base, their mediocaudal angles bluntly rounding, exceeded slightly by genital styles.

Internal genitalia: Lateral valve of ovipositor broad and spoon-shaped, rounding to a sharply pointed apex, the basal laterodorsal half membranous, the ninth sternite about three-fourths the length of the valve. Middle valve flat and bladelike, tapering to a slender pointed apex. Inner valve very broad at base, then tapering to a sharply pointed apex, the two valves united on basal third, the free margins bearing numerous distinct teeth, numbering about eighty-two, and two distinct notches, the one at base of apical third and other one just caudad of middle of valve.

Male genitalia, resembling *proteus*, male styles broad and stout, with base extended into a flap and base of apical portion bearing laterally a recurved hook after which it tapers to a dorsad-curving, sharply pointed apex.

COMPARATIVE NOTES. This species is not readily confused with other species. It resembles *osborni* in regard to the color and wrinkling of the pronotum and the general shape of body, which is long and slender, tapering at both ends. It can be easily distinguished from *osborni*, however, by its striking color and by its great difference in the structure of the male genitalia, which can readily be seen in the drawings. The inner valves of the ovipositor are also considerably different in these two species, the valve in *distincta*, being short, very broad at base and distinctly pointed at apex, with the two notches very close together and about eighty-two teeth between the basal notch and apex. *Osborni*, on the other hand, is a long valve with the notches very far apart and about 105 distinct teeth.

DISTRIBUTION. This species was described from eleven specimens. Four specimens—two males and two females—were taken at Trinidad, Colo., by Dr. C. J. Drake. The holotype was taken by Dr. R. H. Beamer in Coconino county, Ariz. The other six specimens are in the National Museum and bear the label, Williams, Ariz., which is also in Coconino county.

LOCATION OF TYPES. Holotype, male, in the Snow collection, University of Kansas. Allotype, female, in the collection of C. J. Drake, Iowa State College, Ames, Iowa.

HOSTS. Unknown.

Clastoptera osborni Gillette and Baker.

(Plates III, V, IX, XIII, XVII, XXI, XXIV, XXV.)

Clastoptera osborni Gill. and Bak. Hemiptera of Colorado, p. 70; 1895.
Clastoptera obtusa subsp. *osborni* Gill. and Bak. Ball, E. D. Proc. Ia. Acad. Sci. III, p. 190; 1895.
Clastoptera obtusa var. *testacea* Fitch. Ball, E. D. Can. Ent. LIX, p. 109; 1927.
Clastoptera obtusa Say. Van Duzee, E. P. Trans. Am. Ent. Soc. XXIV, p. 111; 1908.

SYNONYMY.

In his original paper (1895) Doctor Ball placed this species as subspecies III under *obtusa*. He distinguished it from the rest of the *obtusa* group by the fact that the face was entirely light and the bands on the front obscure. Under this subspecies he had three varieties, the first one olive-green and yellow, which is the true *osborni*, the second one copper-colored, which he thought was synonymous with *testacea*, and the third one black, which he considered the same as *pini*.

In his recent paper (1927) Doctor Ball synonymizes *osborni* with *Clastoptera obtusa* var. *testacea*. The reasons for doing this he gives in the following paragraph:

> "Baker insists that *osborni* is a distinct species from *obtusa*, and gives differences in the number of pronotal wrinkles and shape of clavus, neither of which appear to be constant. Van Duzee and Stearns follow Baker, but like him they were not acquainted with the var *testacea* of Fitch. If this is a distinct species it will still be *testacea* of Fitch and not *osborni* G and B. Stearns separates *osborni* from all others by the narrow elytra, ignoring the fact that the Colorado forms of typical *obtusa* and all mountain and northern examples of *testacea* have the character equally marked. The only character that is at all constant that the writer finds to separate *osborni* from *testacea* is the lack of black on the bulla, and that appears too trivial to warrant even a varietal status. The writer was in error in calling the subspecies *osborni* as *testacea* has priority; he also erred in including *pini*, which is sufficiently distinct to warrant a separate status."

The writer, on the other hand, has found a number of characters which are constant and yet sufficiently different from *obtusa* to warrant the status of a distinct species. The most evident characteristic is that of the genitalia, which are very dissimilar to that of *obtusa*, as can be seen by the illustrations.

Furthermore, there are sufficient characters available to separate *osborni* from *testacea*, which in turn differs from *obtusa*. In fact the writer thinks that there are three distinct species involved, *osborni*, *testacea* and *obtusa*, with *testacea* standing as the intermediary form between the other two.

ORIGINAL DESCRIPTION.

Female, face two-thirds wider than long, minutely, indistinctly sculptured; clypeus broad at base, gradually tapering to a pointed apex, one-fifth longer than broad, basal suture obsolete, loræ long, nearly as long and half as broad as clypeus; genæ narrow, outer margin concave beneath eyes, convex below the loræ where they are very narrow, touching the clypeus at the broadest part; front but little longer than broad, superiorly very broadly and evenly rounded. Vertex very slightly, transversely depressed, anterior margin carinately elevated, not longer at middle than at eyes. Pronotum transversely wrinkled, minutely scabrous, two distinct pits behind anterior margin near the median line, three-fourths wider than long, anterior curvature three-eighths of length. Scutellum finely and transversely wrinkled and minutely scabrous, longer than wide. Elytra with a fine, thickly set, golden pubescence, entirely, finely, densely punctured. Color pale rufous throughout, tinged with olive-green on pronotum and clavus, beneath more yellowish. Length, 5.5 mm. Described from two females. Large but somewhat narrower across hemelytra than is usual in this genus.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 4.95 mm. to 5.5 mm; ♂ 3.5 mm. to 4 mm. Width: ♀ 2.2 mm. to 2.75 mm.; ♂ 1.66 mm. to 2 mm.

SHAPE. A large, slender species with elytra tapering to a very pointed apex and clavus very long in proportion to rest of elytron.

COLOR. Typically a yellowish, testaceous species, but some forms, especially males, washed in smoky-brown so that they are much darker than the typical form. Front and vertex usually yellow, the latter with an orange-spot laterad and caudad of each ocellus, occasionally entire head washed in smoky-brown. Eyes brownish-grey. Face typically a uniform golden or straw-yellow throughout, postclypeus traversed by nine or more pairs of darker arcs of rufous-tan, but in the darker forms a deep rufous with the arcs in smoky-brown. Pronotum light yellow with central portion underlined with grayish-green, and usually six orange spots on anterior margin, but in the darker forms the entire disc smoky-brown. Scutellum orange-tan on basal two-thirds, rest more light yellow; in the dark series all dark brown. Elytra, yellowish-tan hyaline throughout except where body shows through, making it brownish-gray; those of the dark series a trifle more rufous-brown than typical form. Legs entirely yellow, with dark brown or black spines, occasionally those of the smoky forms washed all over in smoky-brown. Ventral part of body entirely yellow, with ovipositor sometimes washed in smoky.

STRUCTURAL DETAILS Vertex not depressed transversely, anterior margin not distinctly carinated Greatest length of eyes almost one-fourth width of entire head. Ocelli located midway between anterior and posterior margins of the vertex, the distance between the two ocelli not quite three-fourths of the distance between each ocellus and eye Front extending beyond vertex for almost half length of vertex Postclypeus only slightly inflated, arising gradually from face at sides, its length greater than twice the length of the anteclypeus. Pronotum dull, finely pitted, deeply wrinkled, the wrinkles numerous, irregularly broken up into many smaller ones; cephalic margin roundingly produced, posterior margin deeply emarginate, lateral margins diverging; the greatest length of pronotum being posterior to its laterocaudal angle, and the entire head and prothorax more vertical to rest of body when viewed from the side than in other related species Scutellum long, its width two-thirds of its length. Elytra scarcely inflated, long and slender, the length of one elytron almost four times its width; clavus very long proportionately, the distance extending beyond the scutellum being almost equal to the length of the scutellum itself and much longer than the membrane, with the width across apex considerably narrowed; base of costal margin flaring, then parallel-margined for half length of elytron from whence it tapers to a narrow, pointed apex, wings covered by a fine pubescence. Wing venation, cell R_5 much longer than wide, cell R_3 smaller than cell first M_4, apical callous very faint, only slightly elevated, elongate, covering most of cell R_1

External genitalia. Pygofer of female slightly longer than wide, exceeded by ovipositor about one-seventh of its length; ninth sternite slightly over one-half length of valve, pygofer of male approximately twice its length, laterocaudal angles elongated to form a slender ventrad-curving process, genital plates broad at base, their inner margins rounding, exceeded slightly by genital plates

Internal genitalia Lateral valve of ovipositor broad and spoon-shaped, tapering to a roundingly pointed apex, its ventral basal two-fifths membranous; middle valve flat and bladelike, base not greatly expanded, apex broadly tapering, inner valves flat, bladelike, their inner margins united on basal two-fifths, the free apical inner margins bearing two conspicuous notches, one at point of union of the two valves, the other slightly cephalad of base of apical third, with about 105 conspicuous teeth, those between the two notches broad and shallow, but the apical ones deep, tapering caudad Male styles broad and stout, base somewhat pointed, median apical half expanded into a broad, recurved flap, whose laterocephalic angle is elongated into a slender, fingerlike process

COMPARATIVE NOTES *Clastoptera osborni*, although considered by certain writers as a variety of *obtusa*, is without a doubt a distinct species The genitalia of the two are decidedly different, as can be observed by a study of the drawings Several characteristics other than the genitalia are helpful in separating the two In the first place the color patterns of the face are distinctly different, that of *osborni* being uniformly testaceous, while *obtusa* and its varieties typically have the lower half of the face dark Then, too, the general testaceous color of the body in *osborni* separates it from anything in the *obtusa* group The wrinkles of the pronotum are irregular and more numerous than they are in *obtusa*, and the clavus of the elytron in *osborni* is proportionally longer and more narrowed at apex than in *obtusa*

Superficially *Clastoptera osborni* resembles *Clastoptera testacea* more than any other species They both have the same general testaceous coloring, with the pronotum tinged with grayish-green, and with the clypeus all yellow There is one difference in color, however that of the apical callous, which is always light colored in *osborni* and blackish in *testacea*, standing out in sharp contrast to the rest of the elytron

Structurally *Clastoptera osborni* and *Clastoptera testacea* differ in several ways In the first place *osborni* is a large, very slender species with the margins of the elytron almost parallel, or with the widest part of the body anterior to apex of clavus or just back of the pronotum, and with the head and anterior part of the thorax more vertical to rest of body when viewed from the side *Testacea*, on the other hand, has the margin less parallel than *osborni*, so that the widest part of the body is anterior to tip of clavus but not so far forward as in *osborni* The wrinkles on the pronotum of *osborni* are very numerous, deep and irregular, so that they can scarcely be counted, while the wrinkles of *testacea* are not so deep and number about twenty-five or more. The pronotum of *testacea* is more or less shiny, while in *osborni* it is decidedly dull. *Osborni* is distinguished from *testacea* and *obtusa* also by the fact that the pronotum is much longer posterior to its laterocaudal angle than it is from that angle cephalad, but in *testacea* and *obtusa* the distances are about equal. The length of the postclypeus in *osborni* is usually somewhat over twice the length of anteclypeus, and in *testacea* it is usually less than one and one-half times, while in *obtusa* it is usually exactly one and one-half times. The clavus of the elytron in *osborni* is longer in proportion to rest of elytron and more narrowed and pointed at tip than in *testacea*, where it is very broad and rounded. The membrane of the elytron is proportionately much shorter than in *testacea*.

From the above characteristics it can be seen that *C. testacea* is somewhat of an intermediary form between *osborni* and *obtusa*. The genitalia make this even more apparent and prove that there are three distinct species involved. The lateral valve of the ovipositor in *osborni* on the ventral margin has the basal two-fifths membranous, while in *testacea* and *obtusa* at least the basal half is membranous. Also, the sternite of *osborni* is only slightly over one-half the length of the valve, but in *testacea* it is greatly over one-half. The ovipositor in *osborni* protrudes about one-seventh of its length beyond the pygofer, while that of *testacea* protrudes one-ninth. The inner valves of the ovipositors of the three species differ in the following ways: The basal notch on the inner margin is more prominent and the apical notch less prominent in *osborni* than in the other two. The basal notch is located almost exactly midway on valve in *obtusa*, two-fifths of the distance from the base in *testacea* and two-sevenths in *osborni*. The teeth along the inner margins of these valves also differ, those of *obtusa* being finer and more numerous, between 115 and 125, while those of *testacea* and *osborni* are broader and more conspicuous, numbering about 105 in *osborni* and around 85 in *testacea*.

The male genitalia of these forms are likewise specifically different. Those of *osborni* and *testacea* are more nearly alike than those of *obtusa*. The differences can easily be seen by examining the illustrations.

DISTRIBUTION. Stearns (1923) states "Specimens have been examined from Colorado, New Mexico, Wisconsin and Ohio. It has been reported from West Virginia and the District of Columbia (Ball)."

The writer had specimens at hand from two additional states—Arizona and Texas. Doctor Drake has a large series, 63 in all, taken from Trinidad, Colo. In the Snow collection there is another large series of over 200 specimens from Oak Creek canyon, Arizona, indicating that the species is fairly common in the localities where it is found.

The proportions of the sexes for the total number of specimens at hand seems to be about twice as many females as males, the actual number being 209 females and about 107 males. In individual collections this may vary somewhat. For example, in Doctor Drake's collection there were only 17 females as opposed to 46 males.

LOCATION OF TYPES. One female specimen bearing a red-type label is retained at the National Museum, Washington, D. C. The label states that it is from the collection of C. F. Baker, Colorado Springs; collected by E. S. Tucker, July.

HOSTS. The series from Arizona was collected from pine.

Clastoptera testacea Fitch.

(Plates III, V, IX, XIII, XVII, XXI, XXIV, XXV.)

Clastoptera testacea Fitch. Fitch, Asa. Homoptera, New York State Cab. of Nat. Hist., p. 58; 1851.

Clastoptera pini Fitch. Fitch, Asa. New York State Cab. of Nat Hist., p. 58; 1851.

Clastoptera obtusa subsp. II and III *osborni* Fitch. Ball, E. D. Proc. Ia. Acad. Sci., vol. III, p. 190; 1895.

Clastoptera proteus var. *pini* Fitch. Van Duzee, E. P. Cat. of Hemip.; 1917.

Clastoptera obtusa var. *testacea* Fitch. Van Duzee, E P. Cat. of Hemip ; 1917.

Clastoptera proteus var. *pini* Fitch. Stearns, L A. Hemip. of Conn., p. 284; 1923.

Clastoptera obtusa var. *testacea* Fitch. Stearns, L. A. Hemip. of Conn., p. 286; 1923.

Clastoptera obtusa var. *pini* Fitch Ball, E. D. Can. Ent. LIX, p. 111; 1927.

Clastoptera obtusa var. *testacea* Fitch Ball, E. D. Can. Ent. LIX, p. 109; 1927.

ORIGINAL DESCRIPTION.

Clastoptera testacea Fitch. Testaceous; scutel rufous; elytra with a polished callouslike black dot near the apex. Length, 0.20 inches. Found on oaks and pines. No. 715, female.

Var. *a*—A black callouslike dot on each side of pectus. No. 716.

Var. *b*—Pectoral dots present, elytra dots wanting. No. 717.

Var. *c*—The black dots wanting, both on elytra and pectus. No. 718.

Clastoptera pini. Black; head yellow, with a black band on the anterior margin of the vertex; thorax with a yellow band anteriorly; elytra with a broad hyaline, outer margin interrupted in the middle and a black callous dot near the apex. Length 0.14. Found chiefly on pines. No. 719, male.

Var. *a*—A ferruginous dot on the apex of the scutel. No. 720.

Var. *b*—A yellow thoracic band widely interrupted. No. 721.

The writer has done an unusual thing, perhaps, by matching *Clastoptera testacea* with *Clastoptera pini*, and giving them a single name, since only female specimens of *testacea* and only male specimens of *pini* have been reported as being found, except for two males of *testacea* and two females of *pini*, which Doctor Ball states are in his collection But the reasons for thinking that the dark *pini* specimens are the males of the light yellow *testacea* are very convincing. In the first place both species were described by Fitch at the same time from four female specimens of *testacea* and three male specimens of *pini* He states that *testacea* was taken from oaks and pines and *pini* "chiefly on pines." This seems to indicate that they were taken from the same locality and on the same host plants. Secondly, Dr. W. J. Baerg sent the writer a series of specimens taken from Ithaca, N. Y., bearing labels, lot *a*7 lot *a*3, lot *a*10, indicating that they had probably been reared from the same cage, or at least had been collected from the same places. Twelve of these were typical males of *pini*, and five were typical *testacea* females. Also, Dr. L. A. Stearns sent seven female *testacea* and one male *pini* taken from open woods in Virginia, which were evidently taken together. The writer had at hand for study only thirty-three specimens in all, which represents the number found in the larger Cercopid collections in the country. It is evidently a very rare species. Doctor Ball says that he "beat three males and a female of this rare form (meaning *pini*) along with examples of var. *testacea* from *Pinus virginiana* at Chevy Chase, Md."

A third reason for placing them together is that they resemble each other in certain characteristics, one of the outstanding ones being that the face in both forms is always entirely yellow. This immediately separates them from the *obtusa* group and links them with *osborni*. The outstanding thing, however, is the genitalia, which show that both *testacea* and *pini* are closely related to *osborni* and are not like *obtusa*. The inner valve of the ovipositor has more the characteristics of the inner valve of *osborni* than that of *obtusa*, while the male genitalia of *pini* are absolutely different from *obtusa*, but somewhat similar to *osborni*. *Clastoptera testacea*, however, differs from *osborni* in a number of ways, so that they cannot be regarded as synonyms, as Doctor Ball thinks. (His opinion in regard to this matter is quoted in the discussion of *Clastoptera osborni*.) In other words, it would seem that *testacea* and *pini* are intermediary forms between *obtusa* and *osborni*, with the ovipositor of *testacea* showing the same degree of gradation between the two other species as the males styles of *pini* do. Therefore it seems logical to link them together.

Although the writer came to this conclusion independently, she is not responsible for the original idea, since later in checking over Doctor Ball's correspondence she found a reference to this matter in one of his letters, which she had completely forgotten, wherein he stated that he has often tried to synonymize these two species as varieties of a distinct species, because of the fact that they both possess the light-colored faces, but that he could find no other good reasons for placing them together. In his 1927 revision of the genus he therefore treated them as separate forms However, the writer thinks that they should be linked together because of the reasons discussed above. Of course the matter can never be absolutely proven unless mating pairs are taken, which it is to be hoped may sometime be done

Since Fitch described *testacea* first in his paper the writer has retained this name for the species. The type specimens in the Albany Museum are somewhat faded, especially those of *pini*, which are no longer black but a light tan. The types of *testacea* were not *osborni*, so there is no possibility of any confusion resulting from them *

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 4 mm. to 4.25 mm ; ♂ 3.25 mm. to 3.33 mm. Width: ♀ 2 mm. to 2.37 mm ; ♂ 1.87 mm to 2 mm

SHAPE. A moderately elongate species, with margins of elytra fairly parallel, head and pronotum broad.

COLOR. Female, testaceous, front and vertex golden-yellow, eyes dark. Face entirely yellow, postclypeus with eight or nine pairs of darker arcs, tip of labium dark. Pronotum golden-yellow, or sometimes washed in greenish-brown. Scutellum reddish-tan, fading to grayish-tan at apex. Elytra entirely yellowish-tan hyaline with dark body showing through, making the general appearance through middle darker, apical callous blackish. Mesothorax and metathorax, usually entirely yellow, occasionally two dark brown areas on mesothorax, laterad of labium. Abdomen yellow, ovipositor sometimes dark. Legs yellow, excepting tarsal claws and the spines on tibia and tarsus of last pair.

Male black, front and vertex sulphur yellow with black band on anterior half of vertex. Eyes dark. Face, entirely lemon-yellow, the postclypeus traversed by eight or nine pairs of dark tan arcs. Pronotum shining black with a sulphur-yellow band on anterior part. Scutellum black. Elytra, corium dark brown, with a broad clear hyaline area all along costal border and surrounding the black apical callous, interrupted only on middle by narrow extension of the dark brown area, the dark brown portion fading to lighter brown before reaching the hyaline membrane. Mesothorax and metathorax yellow, occasionally two dark brown areas on mesothorax laterad of labium. Abdomen dark brown. Legs yellow, excepting the dark tarsal claws and spines on tibia and tarsus of last pair of legs.

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* By a later examination of his material at the request of the writer, Doctor Ball found that the male specimens of *testacea* were only small female specimens of that form, and that there were no female *pini* specimens in his collection.

STRUCTURE. Vertex somewhat depressed transversely, anterior margin distinctly carinated. Length of eye about one-fourth total width of head. Ocelli located halfway between anterior and posterior margins of vertex, the distance between the two ocelli being two-thirds the distance between each ocellus and eye. Front extending beyond vertex not more than one-third the length of the latter. Face, postclypeus very slightly inflated, arising gradually from face at sides, its length twice or less than twice length of anteclypeus. Pronotum not greatly elevated, shining, finely wrinkled, the wrinkles not as deep as in the *obtusa* group, and fairly regular in line, its width almost twice its length, anterior margin roundingly produced, posterior margin deeply produced, lateral margins slightly diverging. Scutellum, length about one-third greater than its width. Elytra, length about three times the width of one, only slightly inflated, margins almost parallel, so that the widest part of the body is slightly cephalad of tip of clavus; clavus, normal length, its apex very broad, the portion extending beyond tip or scutellum much less than the length of the scutellum, but almost equal to the length of the membrane; surface covered by fine hairs, numbering less than those of *obtusa* or *osborni;* wing venation, cell R_5 much longer than wide, cell R_3 smaller than cell first M_4 and apical callous prominent, occupying all of cell R_1.

External genitalia: Pygofer of female, length equal to width, the ovipositor protruding beyond tip of pygofer for one-ninth of its length, ninth sternite considerably over one-half length of valve. Male plates divided on median line for two-thirds their length, styles exposed a considerable distance beyond pygofer.

Internal genitalia: Lateral valve broad and spoon-shaped, its ventral basal angle membranous for half length of valve, ninth sternite considerably over one-half length of valve. Middle valve expanded at base, tapering to a pointed apex. Inner valve united for about two-fifths of its length, the free inner margins bearing about eighty-two broad, distinct teeth and two notches, one notch at point of union of the two valves, and another just anterior to base of apical third. Male genitalia, styles very broad, base expanded into a flap, and inner margin of apical fourth expanded into a broad flap whose cephalic angle is elongated into a point; connective broad and roughly triangular; œdagus a thick rodlike structure with apical half curved cephalad.

COMPARATIVE NOTES. This species has been confused with *C. osborni* and *C. obtusa* in the literature. For comparison with *osborni* see the discussion under this heading in the description of the latter.

It differs from *obtusa* externally in that the face is entirely yellow, while *obtusa* typically has the lower half of the face dark, or else mottled; the pronotal wrinkles are deeper and more numerous than in *obtusa;* the hairs on the elytra are more numerous, and the length of the postclypeus is usually just slightly less than twice the length of the anteclypeus, while in *obtusa* the former is only about one and one-half times the length of the anteclypeus.

For comparison of the valves of the ovipositor of these three species see the discussion in the description of *osborni*.

The males (*pini*) because they are blackish forms, are easily confused with other dark-colored species in the genus. They can be distinguished from all other species by the all-yellow face. In addition to this they can be separated from *C. proteus* var. *osceola*, and *C. saint-cyri* var. *anceps* and *C. hyperici* by having many wrinkles on the pronotum, whereas these species all have few wrinkles. Likewise it is separated by this character from *C. sierra*, *C. binotata*, and the black males of *C. lineatocollis* and *C. brunnea*, all of which have few but deep wrinkles on the pronotum *C. testacea* (*pini*) is separated from *xanthocephala*, in addition to color pattern of the face by its much larger size.

Lastly the male genitalia separate this species from all the other species very easily. This can readily be seen by examination of plates XXV, XXVI and XXVII. *C. testacea* resembles *C osborni* in this respect more than any of the other species, but is decidedly different from it also.

DISTRIBUTION. The writer had available for study thirty-one specimens from the following states: Minnesota, New Jersey, New York, North Carolina, South Dakota, Wisconsin, and from Washington, D C, and Quebec, Canada. Doctor Ball reports it also from Maryland

Of the thirty-one specimens fourteen were yellow females of the typical *testacea* type and seventeen were males of the black *pini* type.

In a letter to the writer Doctor Ball makes the following remarks: "I have twenty-one females of *testacea* and two males On the other hand I have three males of *pini* and two females, and one female and two males of *pini* were taken at the same time and place with the *testacea* examples, and the only male of that species taken in the east"

LOCATION OF TYPES The types of both *testacea* and *pini* are to be found in the New York State Museum at Albany The specimens are all badly faded, those of the black *pini* males having faded to a light tan or brown, as in the painting. The bullæ of *testacea* are black or dark colored, which proves that Fitch had a form distinct from *osborni*.

HOSTS. In every case where the host plants have been mentioned it has always been pine

Clastoptera obtusa Say.

(Plates III, VI, X, XIV, XVIII, XXII, XXIV, XXVI)

Cercopis obtusa Say. Say, Thomas Compl Writ. II, p 256, 1825

ORIGINAL DESCRIPTION.

Head and anterior part of thorax pale, with three transverse lines, wings varied with brown and pale. Inhabits United States. Body short, oval; head pale yellowish, an elevated reddish-brown, transverse line between the eyes and before the stemmata; front with about nine parallel equidistant reddish-brown lines which are interrupted in the middle and abbreviated at the cavity of the antennæ; antennæ placed in a deep cavity, beyond which the setæ only projects; head beneath black, thorax pale, yellowish before, reddish-brown and rugose with continuous lines behind, anterior edge elevated, reddish-brown; a reddish-brown transverse band on the middle; scutel pale, reddish-brown; hemelytra varied with fuscous and pale, generally forming a band.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 4.65 mm. to 5.1 mm.; ♂ 3.75 mm. to 4.5 mm. Width: ♀ 2.55 mm. to 2.7 mm.; ♂ 2.1 mm. to 2.62 mm.

SHAPE. A somewhat slender species with a broad head and thorax; margins of elytra almost parallel, although the body seems a trifle wider at a point in line with apex of clavus.

STRUCTURAL DETAILS. Vertex depressed transversely, anterior margin somewhat carinated. Greatest length of eye approximately one-fourth the width of head. Ocelli located about midway between anterior and posterior margins of vertex, the distance between the two ocelli almost three-fourths the distance between each ocellus and eye. Front usually extending only slightly beyond vertex, but in a few cases protruding almost half the length of vertex. Face, postclypeus very little inflated, arising gradually from face at sides, its length not much over one and one-half times the length of the anteclypeus, and its width slightly greater than width of gena and eye. Labium reaching to trochanter of middle pair of legs. Pronotum bare and shining, its length a little greater than half its width, about twenty-five regular, deep wrinkles on median line, anterior margin angularly produced, posterior margin deeply emarginate, lateral margins slightly diverging. Scutellum, width about two-thirds of its length, the length being just equal to the distance from tip of scutellum to apex of elytron. Elytra scarcely inflated, length of one not quite three times its width, base of costal margin flaring, then parallel-margined to apical fourth or a point just opposite tip of clavus, from whence it abruptly incurves to rounded apex, their surface covered by many hairs, as compared with other species in the genus; wing venation, cell R_5 rectangular, longer than wide, cell R_3 shorter than cell first M_4, and apical callous irregular in shape, occupying most of cell R_1.

External genitalia: Pygofer about equal in length and width, ovipositor exposed about one-seventh of its length beyond pygofer; male genital plates broad, divided for about three-fourths their length, their inner apical angles rounding; laterodorsal angles of pygofer extended into a long, fingerlike flap, styles exposed for about one-third their length.

Internal genitalia: Lateral valve of ovipositor broad and roundingly pointed at apex, its basal dorsal half greatly membranous, the ninth sternite about two-thirds length of valve; inner valves united for almost half their length, the inner free apical margins bearing small, distinct teeth, numbering between 115 to 125, and two distinct notches, one at point of union of the two valves, and the other at base of apical third; middle valve flat, bladelike, tapering to a pointed apex, its base greatly expanded on cephalolateral angle. Genital styles of males, basal two-thirds broad, apical third narrowed and bent dorsad at an angle with rest of style, the apical angles extended into sharply pointed apices, the caudal one longer than the cephalic one.

Clastoptera obtusa var. *obtusa* Say.

Cercopis obtusa Say. Say, Thomas. Compl. Writ. II, p. 256; 1825.
Clastoptera obtusa var. *pallida* Ball. Ball, E. D. Ia. Acad. Sci. XXVI, p. 145; 1919.

WRITER'S DESCRIPTION.

COLOR. A mottled brown and fuscous species Vertex pale yellow with light reddish-brown band on anterior margin, posteriorly reaching ocelli. Face, lower half of postclypeus and genæ, mandibular sclerites and anteclypeus all blackish-brown, rest of face light cream-yellow with four or five pairs of blackish-brown arcs on postclypeus cephalad of dark portion, sometimes faint indications of lighter areas along posterior and lateral margins of postclypeus, loræ and anteclypeus, and occasionally these lighter areas, merging to form a light band dividing the dark areas Pronotum, anterior half pale straw-yellow, excepting a light reddish-tan band on anterior margin and a second darker reddish-brown band posterior to first, the caudal half shading from lighter brown to very dark brown. Scutellum, basal part orange-tan, fading to lighter yellow with extreme apex and base somewhat washed in fuscous. Elytra, mottled in brown, fuscous and white; clavus mottled brown and fuscous with an oblique, usually indistinct or barely discernible, whitish band across middle, corium mottled brown and fuscous, with an oblique white band which is united at the claval structure with the white claval band, and then extends cephalad across middle of corium to costal margin, where it merges into a large white spot, the white band again divided by a narrow oblique brownish-black band and followed posteriorly by a dark fuscous cloud which forms a dark spot on costal margin, from whence it fades into pale hyaline on apical third with the veins standing out in sharp contrast, the explanate costal margin pale hyaline, apical callous black, bordered anteriorly by white and a small white spot in cell just anterior to apical callous Coxa of first two pairs of legs dark, trochanter yellow with a ventral brown spot, femur dark brown with a whitish spot at apex and sometimes a very faint white line running along cephalic margin, tibia and tarsus washed in a lighter shade of brown excepting the last segment of the tarsus which is brownish black Hind legs with somewhat the same pattern but generally lighter, except for the dark spines Mesothorax blackish, mottled with yellow; anterior part of metathorax dark, rest lighter. Abdomen, segments of the female usually yellow with ovipositor washed in brown; segments of the male dark with the margins yellow.

COMPARATIVE NOTES. *Clastoptera obtusa*, and also its variety *tristis*, may be confused with five closely related species, namely *C. elongata*, *C. pallidocephala*, *C. tricincta*, *C* *ovata* and *C* *siskiyou* The *obtusa* forms can usually be separated from these other forms very easily by the color pattern of the face. In *obtusa* the lower half of the face is all dark, blackish-brown, or else somewhat mottled with lighter brown, while these other species all have a light face with an irregular, dark band across the middle

The inner valves of the ovipositors in these three species differ in the following ways: *Obtusa* has the two notches spaced farther apart than in any of the others, and the distance from the basal notch to apex of the valve is longer than in the others. The only two which approach these proportions in any way are *elongata* and *tricincta*. However, in these two species the valves are longer, different in shape, and with the notches much more distinct than in *obtusa*. The teeth on the valves likewise vary. *Obtusa* has the most, numbering approximately 115 to 125, while *pallidocephala* and *siskiyou* have about 100, *tricincta* about 109, and *elongata* and *ovata* both have an irregularly jagged edge.

The writer does not consider the variety *pallida* Ball as a distinct variety. It was undoubtedly described from teneral specimens which did not have a chance to color up properly.

DISTRIBUTION. This has been taken from the following states: California, Colorado, Connecticut, Illinois, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, North Carolina, Nebraska, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, Vermont, West Virginia, Wisconsin, and from Washington, D. C., and Montreal, Canada.

This seems to be one of the commonest forms found in the United States. It appears in fairly large numbers in whatever locality it is taken. In a series of approximately 200 specimens the sexes are about equally divided.

HOST PLANTS. Doctor Osborn (1916) speaks of it as the "alder spittle bug." Doctor Ball (1927) reports if from alder, basswood and willow. In Kansas it has been taken from weeping oak, walnut and pawpaw trees, as well as the grass and shrubbery beneath these trees. Doctor Readio reared adults from nymphs that were feeding on hop horn beam. Van Duzee states that it is taken abundantly on blueberry. Lintner reported it from linden.

Clastoptera obtusa var. *tristis* Van Duzee.

Van Duzee, E P. Bul Buf Soc. Nat Sci X, p 508; 1912

ORIGINAL DESCRIPTION.

The variety he (Ball) calls *achatina*, as I know from a specimen determined by him, is mostly fuscous, with the vertex and anterior margin of the pronotum narrowly fulvous, the former with a dark line. I propose the name variety *tristis* for this form.

WRITER'S DESCRIPTION.

COLOR. Resembling *obtusa*, except that the ground color is a bronze or golden brown with fewer light markings. Vertex pale yellow with light reddish-brown band on anterior margin, posteriorly reaching ocelli. Face, lower half of postclypeus and genæ, mandibular sclerites, anteclypeus all blackish-brown; rest of face light cream-yellow, with four or five pairs of blackish-brown arcs, sometimes faint indications of lighter areas along posterior, lateral margins of postclypeus, mandibular sclerites and anteclypeus. Pronotum, anterior half pale, straw-yellow, excepting a light reddish-tan band on anterior margin and a second darker reddish-brown band posterior to first, the caudal half shading from lighter brown to very dark brown. Scutellum, basal part orange-tan, fading to lighter yellow, with extreme apex and base somewhat washed in fuscous. Elytra, bronze, or golden-brown, no white band on clavus and only occasionally on corium, where it is barely indicated, posterior to the median, oblique dark band, sometimes the white band being a yellowish-tan, the explanate costal margin pale hyaline, and the apical callous black. Legs and under side of body as in *obtusa*.

COMPARATIVE NOTES. See discussion in the description of the variety *obtusa*.

DISTRIBUTION. Doctor Ball makes the following statement in regard to its distribution: "This form has been taken by the writer on alder at Ames, Iowa, at Kingston, Ontario, in the mountains of Colorado, on the slopes of Mount Shasta, California, and on wild grape in the dense swamps of Florida."

The following is a list of states from which this variety has been collected: Alabama, Arizona, California, Colorado, Iowa, Kansas, Maine, Massachusetts, Michigan, New Jersey, North Carolina, New York, Ohio, Pennsylvania, Florida and from Montreal, Canada.

There seems to be an even distribution of males and females, for the series of 145 specimens at hand for study is divided into 79 females and 66 males.

LOCATION OF TYPES. Collection of E. P. Van Duzee.

HOST PLANTS. From Doctor Ball's statements, given above, it seems that the host plants are probably the same as for *obtusa*. One specimen was collected by Mr. Morrison in the Arnold arboretum, Boston, Mass., from *Tila* sp.

Clastoptera obtusa var. *borealis* Ball.

Ball, E. D. Proc. Ia. Acad Sci. XXVI, p. 145; 1919.

ORIGINAL DESCRIPTION.

Resembling typical *obtusa* in size and pattern, but much darker. Ground color dark, smoky-brown, with the vertex, anterior half of pronotum, except for a narrow transverse band, and the oblique saddle definitely set off in light creamy or white, in sharp contrast. Described from two examples from Nova Scotia from Doctor Brittain, one from Osceola, Wis, collected by the writer, and one from West Virginia. This is the common form in the Rocky Mountains and northern regions, and extends down along the coasts as far as Washington and San Francisco. It was the only form at hand from California at the time the writer reviewed the genus. The western specimens have the band on the pronotum somewhat broken and the lower part of the face light, thus agreeing fairly well with the description of *lineatocollis* Stål, and were so referred. Since that time dark, smoky forms of the species that was known at that time as *delicata* Uhl. have been found in California, and as Baker suggests, they are undoubtedly the form that Stål described.

WRITER'S DESCRIPTION.

COLOR. A mottled brown and fuscous species, resembling *obtusa* but much darker. Vertex and front yellow, with an orange-brown band on anterior margin of vertex. Eyes brown. Face, lower half of postclypeus, lower half of genæ posterior to antennal cavities, mandibular sclerites and anteclypeus all blackish-brown, rest of face light cream-yellow, crossed by five or six pairs of dark arcs, sometimes faint indications of lighter areas along lateroposterior margins of postclypeus, mandibular sclerites and anteclypeus mottled, occasionally these lighter areas merging to form a faint, light band. Pronotum, anterior half straw-yellow with a light reddish-tan band on anterior margin, and a second narrow, dark reddish-brown band posterior to first, the caudal portion shading from lighter brown to very dark brown. Scutellum, basal third orange-brown, sometimes washed in fuscous, followed by a yellow area, then a band of brown, another area of straw-yellow and apex blackish-brown.

Elytra mottled brown, fuscous and white, clavus with a broad, white, distinct band across middle, rest of clavus dark brownish-fuscous; corium, dark brownish-fuscous with the exception of a broad hyaline area at base of costal margin, the hyaline apical third bearing the well accentuated dark brown veins, a white band across middle of corium beginning at the white band on clavus, then running cephalad across corium to costal margin, these two bands together making a prominent white V on each elytron, an oblique dark brown band running through the white band on corium, which broadens into a large, irregular dark brown spot just before reaching costal margin, apical callous black and prominent. Coxa of first two pairs of legs dark, trochanter yellow with a cephalic brown spot, femur dark brown on cephalic and lateral sides, caudad portion somewhat lighter, a whitish area at apex, tibia and tarsus washed in brown. Coxa of metathoracic legs yellow, trochanter yellow with a cephalic spot, femur and tibia as above, with black spines, the base of each spine surrounded by a definite white area.

COMPARATIVE NOTES. The writer thinks that the reasons for making this a distinct variety are not very substantial. It is true that the extreme dark specimens of this variety and the extreme light specimens of *obtusa* are rather conspicuously different. Yet one can find an endless number of gradations between these two forms. In other words, there is no clear line of demarcation which sets off a large series of *borealis* on one hand and a large series of *obtusa* on the other, as can be done with *tristis*.

Clastoptera obtusa var. *borealis* may be very easily confused with two other species, *C. lawsoni* and *C. arizonana*. The three species are somewhat alike in general color pattern, since they are all dark brownish-fuscous species with a distinct oblique white band across elytra. However, both *lawsoni* and *arizonana* have this band much broader than that of the var. *borealis*. Then, too, *lawsoni* has a shiny, semitransparent, darker pronotum than *borealis* has. Moreover *lawsoni* is a more globose species with the margins of the elytra more expanded at base and diverging than in the *obtusa* form where the margins are more nearly parallel. The front of *lawsoni* is more extended anteriorly than in *obtusa*, while the wrinkles of the pronotum are much broader and less numerous.

Clastoptera obtusa var. *borealis* can be separated from *C. arizonana*, in addition to its having a narrower white band on elytra, by the fact that it is much larger, with a much broader head and pronotum and longer body. The costal margins of the elytron flare slightly more in *borealis* than in this species, and the front is clearly more produced in *arizonana* than in *borealis*, its length in the former being even longer than the vertex, while in *borealis* it is scarcely visible beyond vertex. Also, the wrinkles of the pronotum are much finer and more numerous in *borealis* than in *arizonana*, where they seem to have dark furrows between them.

The male genitalia show very little difference between these three species unless they are placed side by side. Then it can be seen that the styles of *arizonana* are stouter and shorter than those of *obtusa* or *lawsoni*. The inner valves of the ovipositors differ, however, and thus indicate that three species are involved. The valve of *borealis* is much larger in every way and the two notches are spread much farther apart than in the other two. The teeth also vary, numbering between 115 and 125 in *borealis,* about 96 in *lawsoni* being very faintly indicated between the two notches, and only about 67 in *arizonana.*

Distribution. Doctor Ball states that he "has taken nymphs and what appeared to be immaturely colored males of this form in abundance on the beaked hazel brush in shaded areas at Woods Hole, Mass., on July 11, 1925. He has taken this form on alder in the Rocky Mountains, on basswood in Iowa, and on grape in a Florida swamp. It seems to be found most abundantly in damp and shaded situations from Nova Scotia to the Pacific, and south to West Virginia in the Appalachians and Colorado in the Rockies."

From the specimens in the collections at hand for study it seems apparent that *borealis* is found along with *obtusa.* It has been taken from the following states: California, Colorado, Connecticut, Iowa, Kansas, Massachusetts, North Carolina, North Dakota, New Jersey, New York, Michigan and Florida.

In a series of 200 specimens the proportion of the sexes is equal.

Location of Types. In the collection of Dr. E. D. Ball, Sanford, Fla.

Hosts. Doctor Ball mentioned beaked hazel brush, alder, basswood, and grape. In Kansas they have been taken on oaks, walnut and pawpaw.

Clastoptera achatina Germar.

(Plates III, VI, X, XIV, XVIII, XXII, XXIV, XXVI.)

Clastoptera achatina Germar. Germar. Zeit. f Ent. I, p 87; 1838.
Clastoptera obtusa subsp. I. var. *c*, Germar. Ball, E. D. Ia. Acad. Sci. III, p. 190; 1895.
Clastoptera obtusa var. *achatina* Germ. Van Duzee, E. P. Cat. Hemip., p. 518; 1917.
Clastoptera obtusa var. *achatina* Germ. Stearns, L. A. Hemip. Conn , p. 286; 1923.
Clastoptera obtusa var. *achatina* Germ. Ball, E. D Can. Ent. LIX, p. III; 1927.

ORIGINAL DESCRIPTION.

Testacea, fronte nigra, elytris ante apicem fuscis, macula submarginali ante apicem nigra, femoribus medio fuscis. Hab. in Pennsylvania, Zimmermann. Two bis 2¼ hr. lang rothgelf oder grau gelf, stirn and Mittleburst, bisweilen auch der Hinter-theil des Bauches schwarz. Deckschilde von der mitte weg bis vor die Spitze Schwarzlichbraun, doch bleibt ein Fleck am Seitenrande heil. Die Ader des vorderrandes fuhrt vor ihrer spitze einem schwarzen Fleck.

WRITER'S DESCRIPTION.

Size. Length: ♀ 4.5 mm. to 4.8 mm.; ♂ 3.45 mm. to 4.05 mm. Width: ♀ 2.7 mm. to 2.85 mm.; ♂ 2.25 mm. to 2.4 mm.

Shape. A semielongate species with a broad head and pronotum resembling *obtusa.*

Color. Front, vertex and pronotum all uniform tawny-yellow, eyes brown. Face yellow, marked as follows: A broad brown band across middle of postclypeus, a large brown spot mesad of band on each gena, a spot caudad of mesocaudal angle of eye, a brown spot on caudal portion of mandibular sclerites and another across anteclypeus, or sometimes all of mandibular sclerites and most of anteclypeus dark brown, with occasionally even the caudal margin of postclypeus somewhat darkened. Scutellum tawny-yellow. Elytra, basal third of clavus and anal margin as far as membrane tawny-yellow, rest of clavus dark fuscous, sometimes with an oblique, indistinct yellow band across middle; corium brownish-fuscous, with an oblique, white band which is united on claval suture with the white claval band, then extends cephalad across middle of corium to costal margin, the white band again divided by a narrow, oblique brownish-black band and followed posteriorly by a dark, fuscous cloud which fades into a tannish-gray hyaline on apical third with the dark veins standing out distinctly, the explanate costal margin pale hyaline, apical callous dark brown or black. Legs, usually a dusky yellow, coxa of first two pairs dark or mottled, femur and tibia light with a longitudinal dark stripe on lateral and cephalic sides which sometimes are very broad, merging together so that the entire cephalic and lateral sides are dark; tarsus, excepting spines and last segment, light. Hind legs light, excepting spines and last segment, which are black. Mesothorax usually dark. Metathorax light or mottled. Abdomen with segments dark, margined in light.

STRUCTURAL DETAILS. Vertex depressed transversely, anterior margin somewhat carinated. Length of each eye one-fourth width of head. Ocelli located a trifle nearer anterior margin of head than pronotum, the distance between the two ocelli equal to distance between each ocellus and eye. Front extending beyond vertex for approximately one-half its length. Postclypeus only slightly inflated, its length approximately twice length of anteclypeus, its width only slightly greater than gena and eye. Pronotum dull, its length slightly greater than half its width, with eighteen to twenty deep wrinkles along median line, the grooves between them wider than in *obtusa*, anterior margin angularly produced, posterior margin deeply emarginated, lateral margins slightly diverging. Scutellum, length about two-fifths greater than width. Elytra, scarcely inflated, length of one almost three times its width, base of costal margin flaring, then almost parallel-margined to apical third of elytron, from whence it abruptly incurves to rounded apex, their surface covered by many hairs, as compared with other species in the genus. Wing venation, cell R_5 rectangular, longer than wide, cell R_3 shorter than cell first M_4, and apical callous small, usually occupying only basal half of cell R_1, rest of cell thickened.

External genitalia: Pygofer of female about equal in length and width, ovipositor exposed about one-seventh of its length beyond pygofer. Male genital plates broad at base, their inner apical angles rounding, laterodorsal angle of pygofer extended into a long, finger-like flap, styles exposed for about one-third their length.

Internal genitalia: Lateral valve of ovipositor broad and roundingly pointed at apex, its basal dorsal half membranous, ninth sternite two-thirds length of valve; inner valves flat, bladelike, united for almost half their length, the free apical margins bearing small distinct teeth, numbering about ninety-five and two distinct notches, one at point of union of the two valves, the other just posterior to base of apical third. Genital styles of males, basal two-thirds broad, apical third narrowed and bent dorsad at an angle with rest of style, the apical angles extended into sharply pointed apices, the caudal one being longer.

COMPARATIVE NOTES. *C. achatina* has been considered as a variety of *obtusa* by many writers. The writer considers it a distinct species for the following reasons: First, because of its outstanding color, namely, the yellow head and pronotum in *achatina*, which separates it very readily from *obtusa*. Then, too, the wrinkles on the pronotum are less numerous in *achatina*, numbering 18 to 20 on median line, while in *obtusa* there are usually about 25. Moreover, the wrinkles are deeper with the grooves between them wider than in *obtusa*. Lastly, the inner valve of the ovipositors of the two species differ, although not as markedly as in other species perhaps. The chief differences are that the valve of *achatina* is more slender and narrow as compared to that of *obtusa* and has fewer teeth, namely, about 95 while those of *obtusa* number between 115 and 125.

DISTRIBUTION. The type locality for this species is given as Pennsylvania. Doctor Ball speaks of it as a "rare species." A series of fifty specimens have been taken in Kansas from Atchison and Leavenworth counties. The specimens from other collections numbered about thirty, making the total number of eighty, of which sixty were females and twenty were males. They have been taken from the following states: Connecticut, Florida, Indiana, Maryland, Massachusetts, Missouri, New Jersey, New York, North Carolina, Pennsylvania, Ohio, Texas, West Virginia, Wisconsin, and from Washington, D. C.

HOST PLANTS. One specimen, collected by Mr. Morrison, in the National Museum collection was taken from the Arnold arboretum, Boston, Mass., on *Tilia* sp.

Clastoptera lawsoni sp. new.

(Plates III, VI, X, XIV, XVIII, XXII, XXIV, XXVI)

SIZE. Length: ♀ 4.05 mm. to 4.5 mm.; ♂ 2.4 mm. to 2.62 mm. Width: ♀ 3.45 mm. to 3.9 mm.; ♂ 2.1 mm. to 2.55 mm.

SHAPE. A broad, short, medium-sized species with gradually rounding head and elytra moderately inflated.

COLOR. A yellow and fuscous species with a conspicuous white band across elytra. Head and vertex solid yellow, occasionally two or three pairs of darkish arcs showing on front and two brownish spots on vertex. Eyes brown. Face yellow, with the following dark markings: An irregular brownish band across middle of postclypeus, not extending to margins in some cases and occasionally almost lacking, another brown spot laterad of this on each gena and a brown spot on apex of anteclypeus. Pronotum, semihyaline on central portion with dark body showing through and giving this portion a darker appearance, the outer edges irregularly margined and spotted with opaque yellow, a broad reddish-brown band across middle. Scutellum cream-yellow, washed in orange or sometimes all reddish-tan, occasionally a reddish-brown band at base and a dark arc across middle. Elytra ground color, fuscous, the clavus bearing a broad, distinct white band across middle, corium with this white band continued transversely to costal margin, thus making a shallow white V on each elytron, the explanate costal margin and apical third of elytron hyaline, an oblique dark band across middle of corium partially dividing the white band, another dark spot just caudad of middle of elytron and a darker brownish cloud caudad of white band, apical callous brownish and apical veins somewhat darker brown than rest of elytron. Legs, coxa of first two pairs yellow at base and dark brown at apex, trochanter yellow, with a cephalic brownish spot, femur yellow with a broad brownish band on both cephalic and caudal surfaces, this cephalic band at apex interrupted by a yellowish, longitudinal spot, tibia brown with a darker brown band indicated on ventral surface, tarsus brown with black claws. Hind leg, coxa and trochanter yellow, femur yellow, with a brown basal ring and a broad band running almost to apex on cephalic surface, tibia mottled fuscous and yellow with apices of spines black. Mesothorax blackish-brown. Metathorax yellow. Abdomen yellow or washed in brown.

STRUCTURAL DETAILS. Vertex not depressed transversely, the anterior margin barely carinated. Length of each eye over one-fourth the width of head. The ocelli located midway between anterior and posterior margins of vertex, the space between the two ocelli about equal to the distance between each ocellus and eye. Front extending beyond vertex about two-thirds length of the latter, gena and front gradually rounding anteriorly from eye, giving the head a characteristic rounded appearance. Postclypeus moderately inflated, its length twice that of anteclypeus, and its width slightly greater than space between its lateral margin and lateral margin of head. Pronotum, width almost twice its length, the anterior margin roundingly angulate, the lateral margins diverging and the posterior margin deeply emarginate, the whole surface very shiny, with comparatively few broad wrinkles, numbering about eleven or twelve on median line. Scutellum, length two-fifths greater than width. Elytra broad and moderately inflated, the length of one about two and one-half times its width, the length of clavus beyond apex of scutellum only three-fifths the length of the scutellum, each elytron narrowed at base, its margins then slightly diverging to a point on line with apex of clavus, from which point it tapers to a bluntly rounded apex. Wing venation, cell R_5 much longer than wide, cell R_3 smaller than cell first M_4, the apical callous small, roughly diamond shaped, occupying only the cephalic portion of cell R_1.

External genitalia: Pygofer of female longer than wide, exceeded by ovipositor for about one-tenth of latter. Pygofer of male, longer than wide, the genital plates divided on median line for about one-half their length, the caudomedian angles tapering toward middle of valve, exceeded by genital styles for about one-half their length.

Internal genitalia: Lateral valve broad and spoon-shaped, tapering to a bluntly pointed apex, the ninth sternite slightly over one-half the length of the valve; middle valve flat and bladelike, tapering to a slender apex; inner valves flat and bladelike, united for half their length, their free inner margins bearing two distinct notches, the one at point of union of the two valves and the other at base of apical third, and about sixteen faintly indicated teeth between the two notches, and about eighty between the apical notch and apex of valve. Internal male genitalia of the *obtusa* type, the style broad and stout, its base expanded into a membranous flap, the basal three-fourths much broader than the apical fourth, with the margins of the former bent together, the narrow apical fourth bent laterad, with its extreme apical angles distinctly pointed.

COMPARATIVE NOTES. For the comparison of *C. lawsoni* with *C. obtusa* var. *borealis* see the discussion in the description of var. *borealis* on page 68.

Clastoptera lawsoni is very similar in appearance and structure to *C. arizonana*, although the two have many characters by which they may be separated. The chief structural differences between these two are as follows: *lawsoni* is a larger, broader species than *arizonana*, with the margins of the elytra greatly diverging and not parallel, while in *arizonana* they are only slightly flaring and parallel. The front of *arizonana* is greatly extended beyond vertex, more so than in either *obtusa* or *lawsoni*, the curve of the head of the latter being evenly rounded so that front and gena are smoothly joined together, while in *arizonana* the anterior curve is broken at junction of gena and front and the head is more pointed.

In color these two differ, since *arizonana* is a chocolate-brown with the white band across elytra very broad, occupying a third of the length of the corium, while in *lawsoni* this band is distinct, but occupies about one-fifth of the clavus, and the general color of the elytra is a lighter brown. Also, the pronotum of *lawsoni* is very shining, transparent, and with a well marked reddish-brown arc crossing the disk, while in *arizonana* the thorax is less shining, more opaque yellow, with the grooves between the wrinkles dark, a narrow brown band just caudad of anterior margin and a second very narrow one across the disk.

The ovipositors of these two closely related species differ in the following respects: the inner valve of *arizonana* is smaller with its base more expanded, followed by a constriction through middle, which *lawsoni* does not have. Then, too, the distance from the apical notch to apex of valve in *arizonana* is less than this same distance in *lawsoni*. Moreover, *arizonana* has fewer teeth, namely, about sixty-seven, with the ones between the notches as distinct as the rest from last notch to apex, while *lawsoni* has about ninety-six, with the ones between the two notches only faintly indicated. The male genitalia are quite similar, showing little difference except when compared side by side. The styles of *arizonana* as compared with *lawsoni* are stouter and shorter.

DISTRIBUTION. This species has been taken in various parts of Arizona, Dixie, Utah, Los Angeles, Cal., and Kerrville, Tex. The majority of the specimens have been taken in Arizona.

The species was described from thirty females and fifteen males. Fifteen specimens were collected by Doctor Beamer, Doctor Readio and Mr. Anderson from Mescal, Ariz., and four specimens by Doctor Ball from Dixie, Utah. The others were specimens from the National Museum collection, which were collected by Uhler, Coquillett, W. D. Pierce, F. C. Pratt, Barker and Schwarz, and H. G. Hubbard.

HOSTS. On the specimens collected by Hubbard and Pierce are labels stating that they were collected from grape.

Clastoptera arizonana sp. new.

(Plates III, VI, X, XIV, XVIII, XXII, XXIV, XXVI)

SIZE. Length: ♀ 3.5 to 3.7 mm.; ♂ 3.52 mm. Width: ♀ 2.17 mm.; ♂ 1.95 mm.

SHAPE. A very small, slender species, parallel-sided with a greatly elongated, enlarged front.

COLOR. A dark-brown and yellow species with a conspicuous broad, white band across elytra. Front yellow, crossed by three or four pairs of reddish-brown arcs. Vertex yellow with a narrow reddish-brown stripe just caudad of anterior margin between the eye and ocellus, another orange spot sometimes present caudad of this. Eyes light brown or tan. Face cream-yellow, with a solid dark brown band extending across postclypeus and gena to eye, there being cephalad of this on postclypeus six or seven pairs of prominent dark brown arcs, the antennal socket, area caudad of eye and a small spot on anteclypeus likewise dark brown. Pronotum cream with the grooves between the wrinkles dark and two distinct brown bands, the one just caudad of anterior margin which sometimes may be broken up into four rectangular spots, the second band forming a narrow arc just anterior to middle of disk. Scutellum creamy with a large reddish-brown spot at base, and a broad dark V across middle. Elytra, brownish, a broad white oblique band across middle third of clavus, this band continuing across corium to costal margin, explanate costal margin and apical third of corium distinctly hyaline with veins, large bulbous apical callous, and an oblique narrow band running through the white band dark, standing out in sharp contrast to rest of corium, the membrane distinctly whitish-hyaline. Legs mostly dark, with coxa of first pair dark on basal half and rest light brown, trochanter with a large brown spot on cephalic surface, femur with a dark brown longitudinal stripe running down middle and a narrow, yellow longitudinal band on either side of it, tibia blackish-brown with a yellow crescent at base, tarsus dark brown and claws almost black. Second pair of legs similar to first, except the femur which is all dark brown on cephalic surface except for an oblique yellow band at apex. Hind legs with coxa, trochanter, and femur like second pair, tibia brownish with large white spots cephalad of lateral spines, the spines brown with black tips, tarsus brown with blackish claws. Mesothorax dark brown. Metathorax dark brown anteriorly, fuscous-tan posteriorly. Abdomen dark brown laterally, the inner margins of pleura and pygofer of female lighter.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin slightly carinated. Greatest length of eye somewhat more than one-fourth the width of the head. Ocelli nearer to anterior margin of vertex than pronotum, the space between the ocelli equal to the distance between each ocellus and eye. Front greatly extended beyond vertex, its length longer than vertex. Postclypeus moderately inflated, more so than in *obtusa* and less than in *proteus*, its length somewhat over twice the length of anteclypeus, its width one-third wider than space between its lateral margin and outer margin of head. Pronotum almost twice as wide as long, anterior margin roundingly angulate, posterior margin deeply emarginate, its surface traversed by broad wrinkles on median line with deep furrows between them. Scutellum one-third longer than wide. Elytra, length of one about three times its width, length of clavus beyond apex of scutellum less than one-half length of clavus, base of costal margins only slightly flaring, as compared to *C. lawsoni*, then parallel-margined to apical third of elytron, from whence they taper to a bluntly pointed apex. Wing venation, cell R_5 just slightly longer than wide, cell R_3 smaller than cell first M_4, the apical callous roughly diamond-shaped, prominent, occupying only the cephalodorsal portion of cell R_1.

External genitalia: Pygofer of female longer than wide, only slightly exceeded by ovipositor, approximately one-eighth or one-ninth of valve. Pygofer of male much wider than long, the laterocaudal angles greatly elongated into long slender processes, the genital plates separated on median line for a little over half their length, the mediocaudal angles bluntly rounded, exceeded by genital styles for about half their distance.

Internal genitalia: Lateral valve of ovipositor broad and spoon-shaped, tapering to a bluntly pointed apex, its laterodorsal half membranous, the ninth sternite about three-fourths the length of valve; middle valve flat and blade-like, tapering to a slenderly pointed apex; inner valve flat and blade-like, its base broad, then constricted, from whence it broadens again abruptly, the two valves united on inner margins for half their length, their free inner margins bearing two notches, the one just caudad of point of union of the two valves, and the other at base of apical third, and thirteen distinct teeth between the two notches and about fifty-four between apical notch and apex. Male style, broad at base, margins of the basal two-thirds bent together, the apical third considerably narrowed and bent laterad, the extreme apical angles in the form of sharply pointed hooks.

COMPARATIVE NOTES. See the discussion under this heading in the description of *C. lawsoni* on page 72.

DISTRIBUTION. The species was described from nine specimens, seven of which were males and two females. The females were collected by Dr. P. A. Readio and Dr. F. H. Snow. The males were collected by Uhler, C. F. Baker, Dr. Snow, and Dr. R. H Beamer.

LOCATION OF TYPES. Holotype and allotype, Snow collection, University of Kansas.

HOSTS. Unknown.

Clastoptera xanthocephala Germar.

(Plates III, VI, X, XIV, XVIII XXII, XXIV, XXVI.)

Germar. Zeit f. Ent., p. 189; 1839.

ORIGINAL DESCRIPTION.

Nigra, capite flavescente, fronts, facia nigra, elytris maculis marginatibus hyalinis, puncta calloso anter apicum nigro, pedibus pallido-fuscaque annulatis.

Habitat in Pennsylvania, Carolina. Zimmerman. One and one-half lin lang. Kopf gelb, under scheitel dunkel, eine qweerbinde auf der unterseite schwarz. Deckshilde schwarz, ein Fleck am vorderrande vor der Spitze, ein anderer, der den ganzen Hinterrand einnimmt, glashell, latzerer mit einem schwarzen schweilegen Punkte vor der Vorderecke Beine gelblich, braun geringelt.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 2.9 mm. to 3.3 mm.; ♂ 2.4 mm. to 3 mm. Width: ♀ 1.95 mm. to 2.1 mm.; ♂ 1.65 mm. to 2.1 mm.

SHAPE. A short, compact species, with margins of the elytra almost parallel.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin slightly carinated. Length of each eye slightly over one-fifth the width of the head. Front exposed beyond vertex about two-thirds of the length of the vertex, more roundingly produced than in the *proteus* group. Ocelli located midway between anterior and posterior margins of vertex, with the distance between the two ocelli equal to the distance between each ocellus and eye. Postclypeus very slightly inflated, its width greater than combined gena and eye, length one and three-fourths times the length of anteclypeus.

Pronotum shiny, with about twenty-three fine, even wrinkles, cephalic margin somewhat more produced than in *proteus* group, posterior margin deeply emarginate and lateral margins diverging. Scutellum very long, one-fifth longer than distance from its apex to apex of elytron. Elytra, length approximately two and two-thirds times width of one, base of costal margin flaring, then parallel-margined to apical fourth, from whence it abruptly incurves to rounded apex, covered by a fairly scant pubescence, less than in *salicis* and *hyperici* but more than in *proteus*. Wing venation, cell R_5 about equal in length and width, or slightly wider than long, cell R_3 much smaller and shorter than cell first M_4, apical callous round and bulging, occupying most of cell R_1.

External genitalia: Pygofer of female about equal in length and width, ovipositor extending beyond pygofer for about one-fifth of its length. Pygofer of the male slightly broader than long, its laterodorsal angle expanded into a long, slender, tapering process; male genital plates broad at base, inner margins rounding to a blunt apex, the genital styles scarcely visible beyond plates.

Internal genitalia: Lateral valve of ovipositor tapering to a pointed apex, its length not quite twice the length of the ninth sternite; inner valves united for approximately half their length, the free apical half bearing regular, distinct teeth, numbering seventy-seven to seventy-eight, and two very small inconspicuous notches, one at point of union of the two valves, the other at base of apical third; the middle valve blade-like, expanded into a sharp angle at base and tapering to a pointed apex. Styles of male broad and stout, base extended into a flap, apical fourth bent dorsad; the apical angles both extended into sharply pointed apices, the inner one longer and more sharply pointed than the outer one.

Clastoptera xanthocephala var. *xanthocephala* Germar.

COLOR. A very dark brown, uniformly colored species. Front from above usually yellow washed in dusky. Vertex usually dark brown with the anterior margin somewhat lighter, in some cases being tannish-yellow like the front. Eyes dark brown. Face, postclypeus all yellow, except for four or five pairs of dark arcs on anterior two-fifths, and a conspicuous dark band extending across the middle, mandibular sclerites and anterior half of anteclypeus yellow, rest of face dark brown with the exception of the area anterior to and surrounding the antennæ. Pronotum uniformly dark brown, or sometimes with a lighter brown band across anterior margin. Scutellum dark brown. Elytra uniformly dark brown and shiny except in the following places: A white hyaline spot half way down costal margin, the explanate costal margin anterior to this subhyaline washed in brown, and the extreme apical portion beyond clavus hyaline with the veins and black apical callous standing out in sharp contrast. First two pairs of legs varying from light to dark brown, with a light spot at base of tibia and sometimes another at apex, tibia of hind legs dark brown with a white spot at apex, and rest of segments light or varigated, with dark brown or blackish spines.

COMPARATIVE NOTES. Since this is a blackish form it may easily be confused with any of the other black forms in the genus, such as C. *proteus* var. *osceola*, C. *saint-cyri* var. *anceps*, C. *hyperici*, C. *binotata*, C. *sierra*, and the males of *lineatocollis* and *brunnea*. From all of these, however, it can easily be separated by the color pattern of the face. In *osceola, anceps* and *hyperici* there is a broad, shining black band on anterior portion of the postclypeus, with the remainder a shining sulphur yellow, while in *binotata* the postclypeus is black crossed by light arcs, and in *sierra* it is all black. On the other hand, *xanthocephala* differs from all of them because the black band extends only across the middle of the postclypeus. *C. xanthocephala* also differs from *osceola, hyperici* and *anceps* in the color pattern of the elytra, since it has a whitish spot half way down on the costal border, which the others lack. *Binotata,* on the other hand, has this spot, too, but can easily be distinguished from *xanthocephala* in that the latter has a more or less shining pronotum with many fine, shallow wrinkles (see drawing) while *binotata* has a dull black pronotum with half as many deep wrinkles. This latter characteristic also distinguishes *sierra* —which is like *binotata*—from *xanthocephala.*

C. xanthocephala differs structurally from the other species in many ways. The ocelli are located farther apart than in *osceola* or *anceps,* the space between the two ocelli in the latter two being about one-half the distance between each ocellus and eye, while in *xanthocephala* these spaces are about equal. The lateral margins of the elytra are parallel in *xanthocephala* and start to curve toward apex at base of apical fourth instead of at base of apical third, as in the others. The scutellum is very long in proportion to the elytra and the membrane of the elytra is proportionately less than in any other of the species, which makes *xanthocephala* look much more blunt than the others.

For discussion of the ovipositors of these species, see page 32 in the description of *binotata.* For comparison of *xanthocephala* with the males of *brunnea* and *lineatocollis,* see page 23.

DISTRIBUTION. *C. xanthocephala* has been taken in the following states: Alabama, Arkansas, Arizona, California, Colorado, Florida, Georgia, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Mississippi, New Jersey, New Mexico North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas and Washington, D. C.

Apparently the species is more or less of a southern form, since it has been taken most abundantly in the southern states such as Georgia, Alabama, Mississippi and Texas.

The distribution of the sexes in a series of 581 specimens taken from all over the United States is about equal, with possibly a few more males than females.

HOST PLANTS. The writer has no notes to contribute as to its host plants. Doctor Ball states that he "has found the frothy masses of this species on many different plants in Florida, ranging from shrubs and trees to grass, but its favorite hosts appear to be *Ambrosia* and *Helianthus.*"

Clastoptera xanthocephala var. *unicolor* Fowler.

Clastoptera unicolor Fowler. Fowler. Biol. Cent. Am. Homop. II, p. 206; 1897.

Clastoptera xanthocephala var. *glauca* Heid. Heidemann. Proc. Ent. Soc. Wash. IV, p. 899 fig. 1901.

Clastoptera xanthocephala var. *glauca* Heid. Van Duzee, E. P. Bul. Buf. Soc. Nat. Sci. X, p. 508. 1912.

Clastoptera unicolor Fowler. Van Duzee, E. P. Cat. of Hemiptera. 1917.

NOTES ON SYNONYMY.

Doctor Ball in 1898 mentioned two color varieties of *xanthocephala* which he called A and B, distinguishing them from each other by the fact that the former was black above while the latter was glaucus. Then Heidemann in 1901 found specimens of spittle bugs growing on chrysanthemums. He reared them out and called them *C. xanthocephala* var. *glaucus* Ball. Along with his discussion he published a drawing, although he gave no written, technical description with the drawing. In 1912 Van Duzee published the following account in the Bulletin of the Buffalo Society of Natural Science Vol. X:

> "There are two distinct and fairly constant varieties of this species found throughout the southern states. Doctor Ball lists them as varieties '*a*' and '*b*.' The former is typical *xanthocephala* Germar, while the latter is a pale glaucus or grayish form, for which I now propose the above varietal name (*Clastoptera xanthocephala* var. *glauca*)."

But according to McAtee the correct name would be *C. xanthocephala* var. *glauca* Heidemann. The reason for this he sets forth in the following paragraph:

> "According to article 25*a* of the International Rules of Zoölogical Nomenclature (further construed in opinion 1) and previously long accepted practice among zoölogists, the name *glauca* as used by Heidemann cannot be considered as *nomen nudum* as done by Van Duzee (1912) because it is accompanied by an illustration."

All of this discussion is somewhat unnecessary, however, since, as Doctor Ball (1927) points out, this form is synonymous with *C. unicolor* Fowler (1898). Fowler's written description fits the variety very well. Moreover, he himself states that it is identical with Fitch's *C. arkansasensis*, a manuscript name. *Arkansasensis*, according to the records of systematists, seems to have been synonymous with the variety *glauca* of *xanthocephala*.

ORIGINAL DESCRIPTION.

A small, oblong species, more or less dilated behind, of a uniform, dirty testaceous color (occasionally reddish), with the pronotum faintly impressed with transverse lines, and the tegmina (especially the clavus) more or less distinctly punctured; legs testaceous; underside somewhat pitchy. 3 millum.; lat. 2 millum. Hab., Mexico (Bilimek, in Mus. Vind. Caes.) Vera Cruz (H. H. Smith); Guatemala, San Geronimo (Champion).

This insect appears to be inseparable from *C. arkansasensis* Fitch (in litl.), and is also allied to *Clastoptera rufescens* and *C. xanthocephala* Germar, as well as to *C. testacea* Fitch; the last mentioned is longer, and differs in several particulars.

WRITER'S DESCRIPTION.

COLOR. Front yellow, vertex yellowish-tan washed in brown. Face yellow, postclypeus crossed by a median transverse black band, cephalad of which are four or five pairs of dark brown arcs; most of anteclypeus dark brown, genæ anterior to and surrounding antennal cavities yellow, rest dark brown or black, except the mandibular sclerites, which are yellow. Pronotum mottled tan and dirty brown, lighter on anterior margin. Scutellum reddish dark brown. Elytra tannish-hyaline, becoming clearer on distal third and anterior to apical callous, a clear white spot midway on costal margin, the dark body showing through, giving a darker cast to the central portion, apical callous black. Legs mottled dark brown and yellow, tarsus of posterior legs yellow with the dark brown spines standing out in sharp contrast. Mesothorax black, metathorax yellow. Abdomen black.

Distribution. The variety seems to have a similar distribution with the species. It has been taken from the following states: Alabama, Arizona, Arkansas, Florida, Georgia, Iowa, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Texas, Virginia, and Washington, D. C.

The distribution of the sexes is about equal, the writer having at hand for study 111 females and 91 males.

Hosts. Apparently the same as for *xanthocephala*.

Clastoptera texana sp. new.

(Plates III, VI, X, XIV, XVIII, XXII, XXIV, XXVI.)

Size. Length: ♀ 4.4 mm. to 4.6 mm.; ♂ 4.2 mm. Width: ♀ 2.7 mm.; ♂ 2.4 mm.

Shape. A fairly large, slender species with front only slightly extended and margins of elytra distinctly parallel, resembling the *elongata* group in size and shape, but more like the *arborina* group in coloring.

Color. A yellow, brown and fuscous species with the general color similar to the *arborina* group. Front and vertex yellowish-tan, the latter with anterior golden-brown band reaching ocelli. Eyes brown. Face light yellow, marked as follows: A broad dark brown band across middle of postclypeus, preceded by five or six pairs of dark brown arcs, a brown spot on gena laterad of band between postclypeus and eye, antennal sockets darkened and a central brown spot on anteclypeus. Pronotum with anterior brown border, becoming narrower at sides, followed by a yellow band, then another brown band of equal width, rest dusky-tan. Scutellum yellow with extreme apex dark. Elytra, clavus yellow at base and along elytral margin for half its distance, rest golden-brownish-fuscous except for an irregular oblique light band across middle with a large dark brown spot at apex; corium with a longitudinal yellow spot near base, explanate costal margin and apical third tannish-hyaline, an oblique dark brown band across middle, interrupted before claval suture, partially bordered anteriorly and entirely bordered posteriorly by yellowish-white, a dark fuscous cloud posterior to white band, a dark spot midway on costal margin, veins and apical callous dark brown, bordered in yellow, a distinct yellow spot at apex of cell R_3. Legs yellow washed in light brown, clavus dark brown, spines on hind tibia brownish with black tips. Mesothorax brown through center, lighter at sides. Metathorax yellow. Abdomen yellow.

Structural Details. Vertex depressed anteriorly, anterior margin slightly carinated. Length of eye slightly over one-fourth the width of the head. Front extended only slightly beyond vertex, not much over one-third length of vertex. Ocelli located much nearer anterior margin of vertex than pronotum, distance between the two equal to the distance between each ocellus and eye. Postclypeus twice as long as anteclypeus. Pronotum almost twice as wide as long, anterior margin rounding, lateral margins diverging, posterior margin deeply emarginate, its surface crossed by distinct but semishallow wrinkles, numbering about twenty or twenty-one along median line. Scutellum approximately one-third longer than wide. Elytra only slightly inflated, length of one about three times its width, base of costal margins flaring, then parallel-margined to apical third, from whence they abruptly taper to a blunt apex, surface covered by a relatively short fine pubescence. Wing venation, cell R_5 longer than wide, cell R_3 much smaller than cell first M_4, apical callous roughly rectangular, occupying only part of cell R_1.

External genitalia: Pygofer of female, length and width equal, exceeded by ovipositor by about one-ninth of length of latter. Male genital plates broad at base, inner margins rounding to a blunt apex.

Internal genitalia: Lateral valve of ovipositor broad, spoon-shaped, tapering to a roundingly pointed apex, its dorsobasal angle membranous, ninth sternite approximately two-thirds length of valve; inner valves flat, bladelike, their inner margins united for little over one-third their length, narrowed through middle, then broadened to form a distinct notch, followed by another distinct notch at base of approximate apical third, the margin between the first notch and apex of valve irregularly jagged and notched without distinct teeth. Male styles broad at base, the margins bent together, apical third slender, narrowed just before apex, then broadening out again with apical angles forming sharp points.

COMPARATIVE NOTES. See the discussion under this heading in the description of *arborina.*

DISTRIBUTION. The species was described from three specimens, two females and one male, collected from Devil's River, Texas, by Bishopp and Pratt.

LOCATION OF TYPES. Holotype and allotype, National Museum collection, Washington, D. C.

HOSTS. Unknown.

Clastoptera canyonensis sp. new.

(Plates III, VI, X, XIV, XVIII, XXII, XXIV, XXVI)

SIZE. Length: ♀ 4.05 mm. to 4.5 mm.; ♂ 3.52 mm. to 4.12 mm. Width: ♀ 1.95 mm to 2.4 mm.; ♂ 1.95 mm. to 2.4 mm.

SHAPE. A medium-sized, slender species, with head and thorax more narrowed than in *C. uniformis,* elytra only slightly inflated, their margins parallel.

COLOR. A cream and tan species, one of the lightest colored species in the genus. Front entirely cream, vertex cream, bordered anteriorly by a black band which is broader across middle third. Eyes yellowish-tan. Postclypeus cream with a broad, almost regular blackish band across middle third, five or six pairs of very faint tan arcs cephalad of this, rest of face cream except for antennal sockets, a spot on each gena laterad of transverse band, an elongate spot caudad of each eye, a spot on apex of anteclypeus and sometimes a small spot on line of demarcation between postclypeus and anteclypeus which are dark. Pronotum solid cream, with a conspicuous blackish rectangular spot on each lateral angle and two irregular brownish spots on anterior margin just caudad and somewhat mesad of the eyes. Scutellum cream, with a faint tannish band at base and an indication of a dark shallow V across middle. Elytra uniformly cream and tan, the clavus entirely opaque cream on basal two-thirds, the apical third tinged with tan and the apical vein brown; corium with explanate costal margin light, mesad of which is a tan area, followed by a large wedge-shaped, opaque yellow area which is divided by a very faint oblique brown band, the rest of elytron tannish-brown, becoming more hyaline near apex, the apical veins and callous, and a small spot in cell first M_4 brown, margined with opaque cream or yellow. Legs, anterior two pairs yellow, marked in dark as follows: Coxa with a conspicuous blackish-brown spot on cephalic surface, a faint spot on trochanter, femur with a broad longitudinal band on cephalic and caudal surfaces which fuse together near apex, leaving a white ring around apex, tibia with a longitudinal black band on cephalic surface fusing with a black basal ring, another short longitudinal bar in the yellow portion, tarsal segments brown with almost black claws. Coxa and trochanter of hind leg cream washed in light brown, femur with two very broad longitudinal dark bands which fuse near apex just anterior to an apical white ring, tibia yellow, spines dark brown with black tips, tarsal segments light except for the last segment, which is washed in brown, and the black spines and claws. Mesothorax brown, darker just laterad of labium. Metathorax yellow. Abdomen yellow with central portion of segments tannish, ovipositor and male pygofer darker.

STRUCTURAL CHARACTERISTICS. Vertex slightly depressed transversely, anterior margin slightly carinated Length of each eye less than one-fourth the width of the head. Front extending beyond vertex for about two-thirds the length of the latter Ocelli located nearer anterior margin of vertex than pronotum, the distance between the ocelli practically equal to the distance between each ocelli and eye Face, postclypeus moderately inflated, its length about twice the length of the anteclypeus and its width slightly greater than distance between its lateral margin and outer margin of the head. Pronotum regularly and semideeply wrinkled, the wrinkles fine, numbering about twenty-three on median line, the anterior margin roundingly produced, the lateral margins diverging and the posterior margin deeply emarginate. Scutellum, width about three-fifths of its length. Elytra covered with a fine, silky pubescence, the length of one about three times its width, the base of costal margin flaring, then parallel-margined for about two-thirds the length of the elytra from whence it tapers to a roundingly pointed apex. Wing venation, cell R_5 much longer than wide, cell R_3 smaller than the cell first M_4, the apical callous very prominent, all of cell R_1 being thickened.

External genitalia · Pygofer of female slightly longer than wide, exceeded by ovipositor very slightly. Pygofer of male wider than long, exceeded by genital styles for about one-half their length, the genital plates separated for about one-half or two-thirds their length, the mediocaudal angles bluntly rounded.

Internal genitalia · Lateral valve of ovipositor broad, spoonshaped, tapering to a bluntly pointed apex, its basal mediolateral angle membranous, the ninth sternite slightly over one-half its length; middle valve flat and bladelike, tapering to a slenderly pointed apex; inner valve flat, bladelike, fairly stout, the inner margins of the two valves united for about one-third their length, their free inner margins bearing numerous fine teeth, numbering about 105, and two distinct notches, the first and less prominent about midway on valve, the other approximately at base of apical third. Male styles broad at base, the margin of the basal two-thirds greatly expanded and folded together, the apical portion much more slender, tapering to a pointed, laterad-curving apex. Connective roughly triangular, œdagus a long slender rod with two membranous lateral flaps on apical half.

COMPARATIVE NOTES. *C. canyonensia* superficially resembles *C. uniformia.* At first glance the color seems to be similar, but upon closer examination there are noticeable differences. In general *canyonensia* is much lighter, with the black marks on vertex and pronotum sharply contrasting with rest of body. In *uniformia* the black marks are not present and the elytra are considerably mottled with fuscous, thus giving them a much darker appearance. Moreover, the postclypeal band is very distinct in *canyonensia* but greatly reduced and inconspicuous in *uniformia*. Besides these color differences there are many structural ones. In the first place *canyonensia* is much smaller, with its head and thorax narrowed anteriorly, while *uniformia* has a much broader head and thorax. Moreover, the front is more produced in *canyonensia* than in the other, and the pronotal wrinkles, although numbering approximately the same along the median line in both species, are in reality closer together in *canyonensia* since the thorax is smaller in *uniformia*. Then, too, the apical callous is large in *canyonensia*, occupying all of cell R_1, but is smaller and inconspicuous in *uniformia*.

In addition to these external differences the ovipositors show variation. The ovipositor of *canyonensia* is smaller and the distance from its apex to first and second notches relatively longer than in *uniformia*. Lastly, the teeth of *uniformia* appear somewhat larger than in *canyonensia*, although this does not check very easily.

DISTRIBUTION. The entire series from which this species was described was collected from the Grand Canyon, Arizona, about nine hundred feet down in the canyon. A series of 233 specimens were taken, of which 136 were males and 97 females. Four mating pairs were taken in this group.

LOCATION OF TYPES. Holotype and allotype in the Snow collection, University of Kansas, The collectors of this large series were Dr. P. A. Readio, Dr. R. H. Beamer and Mr. L. A. Anderson.

HOSTS. Unknown.

Clastoptera uniformia sp. new.

(Plates III, VI, X, XIV, XVIII, XXII, XXIV, XXVI)

SIZE. Length: ♀ 4.8 mm.; ♂ 4.5 mm. Width: ♀ 2.7 mm.; ♂ 2.55 mm.

SHAPE. A rectangular species with margins of elytra parallel, broad head and pronotum, and front extended only slightly beyond vertex.

COLOR. A yellowish-tan species with elytra finely mottled with fuscous. Head, front and vertex yellowish-tan. Ocelli and eyes brown. Face entirely yellow except for an irregular, partially formed brown band through middle of postclypeus and a central longitudinal dark stripe on anteclypeus. Pronotum entirely yellow in female, with four small reddish-tan bars caudad of anterior margin; male with a transverse, arcuated brown band faintly indicated across disk. Scutellum entirely yellow or with basal half reddish-brown bordered in yellow, a narrow dark band midway from base, interrupted through middle. Elytra yellow, finely mottled with fuscous, a small brown arc at base of clavus, a narrow, oblique brown band midway on corium, interrupted before claval suture and broadening into a light-brownish spot on costal margin, veins on apex dark brown, margined in yellow. Coxa and trochanter of first two pairs of legs all yellow, femur yellow with a broad, cephalic dark band; apical portion of band being much darker than basal, tibia yellow with a dark brown ring around base, merging into a longitudinal dark band, another abbreviated dark longitudinal band laterad of this, tarsi yellowish-tan, claws black. Metathoracic leg, coxa and trochanter yellowish, washed faintly in brown, femur yellow with a dark spot midway on lateral margin, tibia brownish tan, spines brown with black tips, their bases surrounded by white, tarsal segments tan, tips of spines and claws black

STRUCTURAL DETAILS. Vertex slightly depressed on each side of ocelli, anterior margin carinated. Length of each eye less than one-fourth the width of head. Front extending beyond vertex not more than one-half length of vertex. Ocelli located nearer anterior margin of vertex than pronotum, the distance between the ocelli less than the distance between each ocellus and eye. Face, postclypeus only slightly inflated, its length about one-third greater than length of anteclypeus. Pronotum very broad, almost twice as wide as long, regularly and semideeply wrinkled, wrinkles numbering about twenty on median line, anterior margin roundingly produced, lateral margins diverging, and posterior margin deeply emarginate. Scutellum approximately one-third longer than wide. Elytra covered with a fine, silky pubescence, length of one elytron approximately three times its width, scarcely inflated, base of costal margins only slightly flaring, then parallel-margined to apical third of elytron, from whence it tapers to roundingly pointed apex. Wing venation, cell R_5 much longer than wide, cell R_3 considerably smaller than cell first M_4, apical callous not greatly convex, occupying only the basal portion of cell R_1, rest of cell thickened but not protruding.

External genitalia: Pygofer of female slightly longer than wide, exceeded by ovipositor about one-ninth of length of latter. Pygofer of male wider than long, genital plates separated for about three-fourths of their length, mediocaudal angles bluntly rounding, exceeded by style at least one-half of their length.

Internal genitalia: Lateral valve of ovipositor broad and spoon-shaped, tapering to a bluntly pointed apex, its basal mediolateral angle membranous, ninth sternite broad and short, slightly over half length of valve; middle valve flat, bladelike, slender, constricted through middle, their inner margins united for about one-third their length, the free margins bearing two notches, the one caudad of base of apical third and the second slightly cephalad of it, the margin between apex of valve and basal notch divided into about 108 caudad-pointing teeth. Male styles broad at base, margins of basal two-third greatly expanded and folded together, apical portion very slender, tapering to a pointed, laterad-curving apex. Connective roughly triangular, œdagus a long, slender red with two membranous lateral flaps on apical half.

COMPARATIVE NOTES. See the discussion under *canyonensis*.

DISTRIBUTION. The species was described from two specimens, a male and a female, collected by Uhler in Arizona.

LOCATION OF TYPES. U. S. National Museum collection, Washington, D. C.

HOSTS. Unknown.

Clastoptera elongata sp. new.

(Plates III, VII, XI, XV, XIX, XXIII, XXIV, XXVII.)

SIZE. Length: ♀ 4.8 mm. to 5 mm.; ♂ 4.2 mm. to 4.5 mm. Width: ♀ 2.4 mm. to 2.7 mm.; ♂ 2.28 mm. to 2.4 mm.

SHAPE. A long, slender species with margins of elytra uniformly parallel and little inflated.

COLOR. A brownish-fuscous species marked with yellow and white. Front cream-colored traversed by three or four dark brown arcs. Vertex creamy-yellow with an interior orange-brown band which widens at ocelli. Eyes brownish-gray. Face creamy-yellow with dark brown markings as follows: The antennal sockets, a spot on each gena, the area caudad of each eye, a transverse band across middle of postclypeus which fuses with spots on genae, four or five pairs of heavy black bands anterior to this band, a small spot on clypeal suture, and a large spot on distal portion of anteclypeus. Pronotum cream-yellow, with caudal third dark, reddish-brown, a red-brown band on anterior margin, sometimes a second brown band with its lateral margin always darker brown, or occasionally this band only indicated at the sides, entirely lacking through middle. Scutellum golden-brown, irregular margined laterally with cream. Elytra, clavus a mottled bronze-brown, with usually a light irregular oblique band indicated across middle, corium a fuscous-bronze or brown, becoming more hyaline on apical third of body and with the following other markings: Explanate costal margin cream hyaline margined faintly in brown, a dark brown oblique band across middle, irregularly margined on both sides with white, the posterior white margin broadening into a white spot on costal margin, the apical callous and veins on distal third and a round spot in cell first M_4 very dark brown, and the cell anterior to apical callous hyaline; legs, coxa and trochanter of anterior two pairs yellow with a dark spot on cephalic surfaces, femur yellow with a very broad, longitudinal dark brown band, tibia mostly dark brown except for a cream-colored crescent near base on cephalic surface and another cream-colored spot at apex, tarsus brownish with last segment darker and tarsal claws almost black. Hind leg with coxa and trochanter tannish, femur with a broad, longitudinal band which becomes much darker toward apex, tibia fuscous with white areas cephalad of the lateral and apical spines, the spines themselves darker with blackish tips, tarsus tannish with black spines. Mesothorax tan on lateral margins, becoming very dark brown laterad of labium. Metathorax tan. Abdomen mottled in fuscous and yellow.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin slightly carinated. Eyes, their greatest width one-fourth width of head. Ocelli located slightly nearer anterior margin of vertex than pronotum, the distance between the two ocelli about equal to the distance between each ocellus and eye. Front extending beyond vertex for about one-half its width. Postclypeus only moderately inflated, arising gradually from face at sides, its length about twice the length of the anteclypeus. Pronotum distinctly wrinkled, numbering about eighteen or twenty along median line, the wrinkles on caudal part more irregular and broken up than on the cephalic portion, cephalic margin roundingly produced, caudal margin deeply emarginate, and lateral margins short and slightly diverging. Scutellum about one-third longer than wide

Elytra scarcely inflated, long, slender, the length of one about three and one-half times its width, distance beyond apex of scutellum longer than length of scutellum itself, the elytra covered by a moderately fine pubescence, base of costal margin flaring, then parallel-margined to approximate apical third of elytron from whence it rounds to a somewhat pointed apex. Wing venation, cell R_5 much longer than wide, cell R_3 smaller than cell first M_4, apical callous prominent, occupying all of cell R_1.

External genitalia: Female pygofer, length slightly longer than width, exceeded by ovipositor for about one-fourth length of latter. Pygofer of male about one-third longer than wide, laterocaudal angles greatly elongated to form a slender ventrad-curving process; genital plates broad at base tapering to a roundingly pointed apex.

Internal genitalia: Lateral valve of ovipositor broad, spoonshaped, tapering to a bluntly rounded apex, its ventral basal half membranous; middle valve flat, bladelike, base greatly expanded, then constricted, from whence it broadens out again, after which it tapers to a slender pointed apex. Inner valves flat, bladelike, their inner margins united for about half their length, the free apical margins bearing two conspicuous notches, the one at point of union of the two valves, the other at base of apical third, the margin between the two notches bearing very fine teeth, the rest from the last notch to apex having an irregular jagged edge but no distinct teeth. Males, basal one-half broad, its lateral margins expanded and bent together, the apical third slender, the extreme apical portion bent laterad and tapering to a slender apex. Connective about twice as wide as long, roughly triangular; œdagus a broad, straight rod, the apical half bearing two lateral broad membranous flaps.

COMPARATIVE NOTES. This group of five species, *C. elongata, C. tricincta, C. pallidocephala, C. ovata and C. siskiyou,* has caused the writer considerable trouble. Ordinarily the erection of five species resembling each other as closely as these do would not be justifiable. Externally they are exceedingly hard to distinguish, except by color. Yet the ovipositors show differences which are of enough importance to use as specific characters, that is, if the inner valve of the ovipositors in the other species is of taxonomic importance. It is so evident in other species in the genus that the ovipositors have specific value that in order to be consistent one would have to accept the evidence they offer here. Moreover, to find out whether the ovipositors are consistent for a given species or not six slides of *elongata* were made, five from one locality in New Mexico and one from Colorado, and five slides of *pallidocephala* were made. In every case they held true to form.

These five species can be grouped into groups rather easily, based upon certain external characteristics. *C. ovata* and *C. siskiyou* can be separated from the other three in that they are much shorter and broader, and the front extends beyond vertex the length of the vertex itself, while in the other three it extends not over half the length of the vertex.

The three species, *C. elongata, C. pallidocephala* and *C. tricincta,* can be told apart externally only by color. Of the three, *pallidocephala* causes the least trouble. The head and pronotum of this species are typically lighter colored than in the other two. The front, vertex, and pronotum usually are cream-yellow with only occasionally dark markings, occurring in the following places: An interrupted dark band on anterior margin of vertex, sometimes the beginning of a band on each side of pronotum, which usually is lacking through the middle or sometimes the posterior third of pronotum with a touch of dark, and also four small brownish bars on anterior margin. Besides this, the cephalic dark arcs, which in the other species are usually conspicuous, are very faint in *pallidocephala,* so that the combination of light postclypeus, plus the lack of a band on anterior margins of either vertex or pronotum, distinguishes this from the rest.

C. elongata and *C. tricincta* cannot be readily separated externally. When looking at a series of each species they appear to be different; yet there seems to be no clear-cut character by which the two may be separated. Usually the three anterior bands seem to be more prominent in *tricincta,* which suggested its name. However, this is not always a means of identification, since specimens of *elongata* grade into this. Therefore, it seems that the structure of the inner valves of the ovipositors, plus locality labels, are the only criteria for determining these species correctly.

The five species mentioned above differ in respect to the ovipositors as follows: *C. ovata* and *C. siskiyou* are separated from *C. elongata, C. pallidocephala* and *C. tricincta* by the fact that the distance between the first notch and base of valve in the first two is greater than in any of the others, and that consequently the two notches are much closer together. Moreover, the valves of *siskiyou* and *ovata* are smaller, and for that reason the teeth of *siskiyou* appear finer than those of *tricincta* or *pallidocephala,* although in actual number they are about the same as the others, there being about 100 in both *siskiyou* and *pallidocephala* and 109 in *tricincta. C. siskiyou* and *C. ovata* are separated from each other chiefly by the fact that *ovata* has no distinct teeth from apical notch to apex, but only an irregular, jagged margin. *Elongata* is also separated by this characteristic from *pallidocephala* and *tricincta.* The valves of these last three species are very similar. The differences which can be pointed out are as follows: *elongata* and *tricincta* are more curved or bow out through the middle, while *pallidocephala* does not. Then, too, the notches, particularly the apical one, in the first two are more distinct and protruding than they are in *pallidocephala.* These two facts make *tricincta* more nearly like *elongata.* On the other hand, it resembles *pallidocephala* by having teeth from apical notch to apex, which are lacking in *elongata* where this margin is only irregularly jagged. Lastly, there appear to be a few more teeth in *tricincta* than in *pallidocephala* and the basal notch is nearer the base than in the later. From these observations, it is apparent that *tricincta* is an intermediary form between *elongata* and *pallidocephala,* but differs enough according to the inner valves from either one to be placed by itself.

The males of these five species are all considerably darker than the females, but in general follow the color differences of the females. The male genitalia, as in other species, are of little taxonomic value.

For comparison with *C. obtusa* and its variety *tristis,* see the discussion in the description of *C. obtusa* var. *obtusa* on page 65.

DISTRIBUTION. A large series have been taken from Taos, Taos county, New Mexico, of which forty-four were females and forty-five were males. These were collected by Dr. R. H. Beamer, Dr. P. A. Readio and Mr. L. A. Anderson. They have also been collected from Colfax county, New Mexico, by Mr. Anderson; from Las Vegas, N. Mex., by Barber and Schwarz; and from Pecos, N. Mex., by C. Heinrich (?). In Colorado they have been collected by C. F. Baker and Uhler; from Poudre Canyon by Dr. P. B. Lawson and Dr. R. H. Beamer; from Estes Park by Dr. C. J. Drake, Mr. Hottes and Professor Severin; and from Pingree Park by Dr. C. J. Drake. One specimen from Gotha Orange, Fla., in the Snow collection, states that it was collected by E. R.

LOCATION OF TYPES. Holotype and allotype in the Snow collection, University of Kansas.

HOST PLANTS. Doctor Beamer reports that the large group collected in Taos, N. Mex., were found on cedar and birch. One specimen collected at Pecos, New Mex., bears a label stating that it was found on *Populus angustifolia.*

Clastoptera pallidocephala sp. new.

(Plates III, VII, XI, XV, XIX, XXIII, XXIV, XXVII)

SIZE. Length: ♀ 4.5 mm. to 5.4 mm.; ♂ 4.2 mm. to 4.8 mm. Width: ♀ 2.4 mm. to 3 mm.; ♂ 2.4 mm. to 2.7 mm.

SHAPE. A rather elongate species, but more robust than *elongata* or *tricincta,* with margins of elytra subparallel.

COLOR. A fuscous bronze and yellow species with head and thorax lighter in color than in any of the closely related species. Front and vertex cream-yellow, occasionally indications of an interrupted dark band on anterior margin of vertex. Eyes yellowish-brown or gray. Face cream yellow, a very dark brown transverse band across middle of postclypeus, which occasionally fades out at sides or else merges with another dark brown spot on gena, six or seven pairs of dark arcs preceding the transverse band, the cephalic three or four pairs being very faint and almost indiscernible; the antennal sockets, area caudad of eyes and lower half of anteclypeus dark brown. Pronotum usually entirely yellow with the beginning of a dark brown band across middle, which becomes very faint as it crosses the disk or is entirely lacking across the middle, and also occasional indications of dark on the distal third or half with four small brownish bars or spots along anterior margin. Scutellum reddish-brown at base with irregular lateral margins, and apex a light yellow. Elytra, clavus uniformly fuscous, occasionally indications of an oblique light band across middle; corium fuscous, except for an oblique dark brown band across middle, prominent dark brown veins, conspicuous apical callous and a round spot in cell first M_4, the explanate costal margin, apical third and membrane hyaline, the oblique dark band bordered by white, which becomes a white spot on costal margin, all of the apical callous and veins margined in white. Legs, coxa and trochanter of first two pairs yellow, with a ventral dark spot on each; femur yellow with a longitudinal dark brown stripe, tibia with a dark ring around base which becomes a ventral, longitudinal dark stripe, another narrow longitudinal bar on lateral surface. The hind legs mottled yellow and fuscous with brownish spines, becoming black at tips. Mesothorax yellow with a large brownish area on each side of labium. Metathorax yellowish. Abdomen mottled light brown and yellow.

Males very much darker, but like females having a light colored head and thorax.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin slightly carinated. Length of each eye one-fourth width of head. Ocelli located slightly nearer anterior margin of vertex than pronotum, the distance between the ocelli about equal to the distance between each ocellus and eye. Front extending beyond vertex for about one-half its width. Postclypeus only moderately inflated, arising gradually from face at sides, its length about twice the length of the anteclypeus. Pronotum distinctly wrinkled, the wrinkles numbering eighteen or twenty along median line, more irregular and broken up on caudal lobes than on disk, cephalic margin roundingly produced, caudal margin deeply emarginate and lateral margins short and slightly diverging. Scutellum about one-third longer than wide. Elytra scarcely inflated, very long and slender, the length of one about three and one-half times its width, distance beyond apex of scutellum longer than length of scutellum itself, covered by a moderately fine pubescence, base of costal margins flaring, then parallel-margined to approximate third of elytron, from whence they round to a somewhat pointed apex. Wing venation, cell R_5 much longer than wide, cell R_3 smaller than cell first M_4, apical callous prominent, occupying all of cell R_1.

External genitalia: Pygofer of female slightly longer than wide, ninth sternite about three-fifths of length of lateral valves, the latter extending beyond pygofer for about one-seventh of their length. Pygofer of male one-fourth broader than long, its laterocaudal angles elongated to form a slender ventrad-curving process, genital plates broad at base, somewhat tapering caudad, their inner apical angles bluntly rounded, and the genital styles exposed beyond plates for about one-half their length.

Internal genitalia: Lateral valve of ovipositor broad and spoon-shaped, tapering to a bluntly rounded apex, its ventral basal half membranous; middle valve flat and bladelike, base greatly expanded, then constricted, from whence it broadens out again, then tapers to a slenderly pointed apex. Inner valves flat and bladelike, their inner margins united for considerably over half their length, the free apical inner margins bearing two conspicuous notches, the basal one at point of union of the two valves and the second at base of apical third of valve, the free margins bearing numerous fine teeth, numbering approximately 100. Male styles, basal part broad, its lateral margins expanded and converging, the apical portion bent laterad and tapering to a slender apex.

COMPARATIVE NOTE. See discussion under *Clastoptera elongata.*

DISTRIBUTION. This species has been taken only from Arizona, California and New Mexico. Only one specimen, a male, was collected in New Mexico by Cocherell. A fairly large series was taken in Oak Creek Canyon, Arizona, by Dr. R. H. Beamer and Dr. P. A. Readio, of which twenty-six were females and thirty-nine males. From Coconimo county, Arizona, six females and seven males were collected by Doctor Beamer and Mr. Anderson, and four specimens were taken by Mr. Anderson in the Grand Canyon. In Uhler's collection in the National Museum there is one specimen labeled from Arizona, and Doctor Ball sent the writer one specimen from Castello, Cal., collected by E. G. Titus.

It would seem, therefore, that this is a restricted species and that the sexes are approximately equal with a slight margin in favor of the males.

LOCATION AND TYPES. Holotype and allotype in the Snow collection, University of Kansas.

HOST PLANTS. Unknown.

Clastoptera tricincta sp. new.

(Plates III, VII, XI, XV, XIX, XXIII, XXIV, XXVII.)

SIZE. Length: ♀ 4.5 mm. to 5.4 mm.; ♂ 4.2 mm. to 4.5 mm. Width: ♀ 2.55 mm. to 2.85 mm.; ♂ 2.25 mm. to 2.4 mm.

SHAPE. A long, slender species, with margins of the elytra parallel.

COLOR. A brownish-fuscous or bronze species marked with yellow and white. Front cream-yellow with usually three pairs of dark arcs. Vertex yellow with a reddish-brown anterior margin. Eyes dark brown or greyish-brown. Face, postclypeus yellow, with a transverse black band across middle preceded by seven or eight pairs of distinct brownish-black bands on the antennal cavities, a spot on each gena adjacent to band on postclypeus dark brownish-black. Pronotum cream-yellow with a dark reddish-brown band on anterior margin, followed by a narrow reddish-brown band, and a third broad brown band on caudal two-fifths. Scutellum reddish-brown, margined irregularly with cream-yellow. Elytra, clavus bronze-fuscous, occasionally an indication of a faint oblique light band across middle, corium a fuscous-bronze or brown, becoming more hyaline on apical third of body with the following white and dark markings: Explanate costal margin cream-hyaline, margined faintly in brown, a dark brown oblique band across corium, irregularly margined in white which becomes a white spot on costal margin, the apical callous, veins on distal third and a round spot in cell first M_4 very dark brown, the cell anterior to apical callous pale hyaline. Legs, coxa of first two pairs yellow, mottled in brown, trochanter yellow with a cephalic brown spot, femur yellow with cephalic and caudal dark brown stripes, tibia mostly dark brown or blackish mottled with light, tarsus dark brown with tips of spines and claws almost black. Hind legs lighter, mottled with fuscous and with blackish spines. Mesosternum reddish-tan, metasternum yellow. Abdomen reddish-brown, margined anteriorly and posteriorly with yellow.

STRUCTURAL DETAILS. Same as for *Clastoptera elongata* in regard to general external characteristics.

External genitalia: Pygofer of female, length almost equal to width, ovipositor protruding one-sixth of its length beyond pygofer. Pygofer of male slightly wider than long, its laterocaudal angles elongated to form a slender ventrad-curving process; genital plates broad at base, their inner margins bluntly rounding at apex, exceeded by genital styles at least one-half their length.

Internal genitalia: Lateral valve of ovipositor broad, spoon-shaped, tapering to a bluntly rounding apex, its ventral, basal half membranous. Middle valve flat, bladelike, base greatly expanded, then constricted, from whence it broadens out again, then tapers to a pointed apex. Inner valves flat, bladelike, united on inner margins for half their length, free apical inner margins bearing two conspicuous notches, one at point of union of two valves, the other at base of distal third, or two-thirds of the distance from base of valve, and numerous fine, regular teeth between the first notch and apex of valve, numbering at least one hundred and nine.

DISTRIBUTION. This species was described from seven females and two males. Three females were collected at Fort Garland, Colo., two from Veta Pass, Colo., and one from Trinidad, Colo. The two males were taken at Fort Garland, Colo. These specimens were taken by Dr. C. J. Drake and Mr. Hottes.

LOCATION OF TYPES. Holotype and allotype in the collection of Dr. C. J. Drake, Iowa State College, Ames, Iowa.

Clastoptera ovata sp. new.

(Plates III, VII, XI, XV, XIX, XXIII, XXIV, XXVII.)

SIZE. Length: ♀ 4.65 mm. to 4.8 mm.; ♂ 4.05 mm. to 4.8 mm. Width: ♀ 2.7 mm. to 2.85 mm.; ♂ 2.4 mm. to 2.77 mm

SHAPE. A short, stout species, much broader than *elongata, pallidocephala* or *tricincta,* and even slightly broader than *siskiyou* which it so closely resembles in other respects.

COLOR. A yellow, golden-brown and fuscous species. Front and vertex cream-colored with three or four pairs of dark arcs and a dark brown band along anterior margin in sharp contrast. Eyes, light brown. Face cream-yellow, a very dark brown band across middle third of postclypeus, preceded by seven or eight pairs of distinct, narrow, dark arcs, the antennal cavities, a large spot on each gena laterad of transverse band, another large spot caudad of each eye and a conspicuous central spot on anteclypeus dark brown, or occasionally the band on postclypeus and spot on anteclypeus much broader and distinct. Pronotum cream-colored, with the anterior margin, a median narrow transverse band and a broad posterior band in light brown. Scutellum orange-brown fading to cream-yellow at apex, with a blackish spot just before apex. Elytra, clavus uniformly bronze or brown with occasional indications of a faint, oblique white band across middle and the area preceding it darker brown; corium mostly bronze-fuscous, becoming hyaline on apical portion with the following markings: An oblique dark brown band across middle, irregularly margined anteriorly and posteriorly with white, this posterior white margin broadening into a distinct white spot on costal border, the explanate costal margin hyaline, as is also the apical third and membrane, with the veins in this region dark brown, standing out in sharp contrast and margined with whitish-yellow. Legs more or less mottled with yellow and dark brown, coxa and trochanter of first two pairs tan, with a dark spot on cephalic surface of each, femur tan, washed in dark brown which forms two longitudinal lines on ventral surface and a dark ring, followed by a cream-colored ring or spot just before apex, sometimes the entire femur dark except for a lateral light stripe; tibia of first two pairs of legs tan, washed in dark brown, which forms a dark spot at base, followed by an oblique white band or crescent, and also another white spot located on apex; tarsus tannish-brown with the tarsal claws very dark brown or blackish. Hind legs yellowish-tan with a dark brown spot on lateral margin of femur sometimes becoming a broad band, spines of tibia and tarsal claws blackish. Mesothorax mostly dark brown, especially on either side of the labium. Metasternum and abdomen light yellow or with the abdomen also washed in dark.

The males of this species, as in the other species, are considerably darker than the females. They can be distinguished from the males of *siskiyou* by having a distinct band across the pronotum.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin slightly carinated. Length of one eye approximately equal to one-fourth the width of the head. Ocelli located much nearer the anterior margin of the head than to the posterior, the distance between the ocelli about equal to distance between each ocellus and eye. Front extending beyond vertex as much as the length of the vertex. Postclypeus only moderately inflated, arising gradually from face at sides, its length about twice the length of the anteclypeus, and its width about one-third wider than distance from lateral margins to outer margins of head. Pronotum evenly and deeply wrinkled, numbering about seventeen along median line, cephalic margin not greatly produced, lateral margins narrowed at base and slightly diverging, the hind margin semideeply emarginate. Elytra only slightly inflated, the length of one about twice its width and the length beyond apex of scutellum only slightly longer than length of scutellum itself; elytra covered by a median fine pubescence; wing venation, cell R_5 longer than wide, cell R_3 much smaller than cell first M_4, apical callous very prominent, occupying all of cell R_1.

External genitalia: Pygofer of female, length equal to width, exceeded by ovipositor between one-seventh or one-eighth of length of latter. Pygofer of male, length about equal to width, its laterocaudal angles greatly elongated to form a slender ventrad-curving process; genital plates broad at base, tapering to a roundingly pointed apex, exceeded by genital styles about one-half their length.

Internal genitalia: Lateral valve of ovipositor broad and spoon-shaped, tapering to a bluntly rounding apex, its laterobasal half membranous; middle valve flat and bladelike, base greatly expanded, then constricted, from whence it broadens out again, then tapers to a slenderly pointed apex. Inner valve flat and bladelike, their margins united for half their length, the free apical inner margins bearing two notches, the first and less prominent at point of union of the two valves and the second at base of apical third, the margin between the two notches bearing very fine teeth, the rest of margin from the last notch to apex having an irregularly jagged edge.

Male styles, basal one-half broad, its lateral margins expanded and bent together, the apical third slender, the extreme apical portion bent laterad and tapering to a slender apex. Connective about twice as wide as long, roughly triangular; œdagus a broad, straight rod, the apical half curving dorsad and bearing two lateral, broad membranous flaps.

COMPARATIVE NOTES. *Clastoptera ovata* resembles the following four species very closely; *C. siskiyou*, *C. elongata*, *C. tricincta* and *C. pallidocephala*. Of these four it is more closely related to *C. siskiyou* than any of the others. In fact these two, *C. ovata and C. siskiyou* can be separated from the other three without much trouble by the fact that they are shorter and broader and the front extends beyond vertex as much as the length of the vertex, while in the other three it protrudes not over half the length of the vertex, thus resembling *C. obtusa* in this respect. For comparison of the ovipositors see the discussion in the description of *C. elongata* on page 86.

Clastoptera ovata and *Clastoptera siskiyou* can only be separated externally by minor differences in color. In *siskiyou* the pronotum is decidedly yellow with only a narrow brown band on anterior margin and a much broader one on posterior part, with no third band crossing the yellow one. In *ovata* there is always a distinct third brown band running through the yellow band, although in one or two male specimens this band was interrupted and somewhat indistinct. Structurally there is, of course, a difference in the ovipositors, the inner valve of *ovata* having a jagged inner margin, while that of *siskiyou* has fine teeth.

DISTRIBUTION. They have been collected from California in the following places: Castello by E. G. Titus; Siskiyou county by E. C. VanDyke; Santa Cruz county and Maria county, collectors unknown. They have also been taken in Oregon by C. F. Baker; Wyoming, collector unknown; and British Columbia by R. P. Currie. The species was described from fourteen specimens, six of which were females and eight males.

LOCATION OF TYPES. Holotype and allotype in the National Museum collection, Washington, D. C.

HOST PLANTS. Unknown.

Clastoptera siskiyou sp. new.

(Plates III, VII, XI, XV, XIX, XXII, XXIV, XXVII.)

SIZE. Length: ♀ 4.5 mm. to 5.4 mm ; ♂ 3.9 mm. to 4.5 mm. Width: ♀ 2.62 mm. to 3.3 mm.; ♂ 2.4 mm. to 2.7 mm.

SHAPE. A shorter species than *elongata, pallidocephala* and *tricincta*, but somewhat more slender than *ovata* although approximating it in length.

COLOR. A golden-brown and yellow species. Front and vertex golden-yellow with the anterior margin of vertex brown, as well as two or three pairs of brown arcs on front. Eyes light gray-brown, sometimes darker. Face creamy, with a dark-brown band across middle third of postclypeus anterior of which are six or seven pairs of distinct dark arcs, the antennal cavities, a spot on each gena just laterad of transverse band, area posterior to each eye, and a spot of varying size on anteclypeus, dark brown. Pronotum yellow with a fairly wide brown band on anterior margin and a very broad brown band on posterior portion, making the median yellow area stand out distinctly, although occasionally a faint indication of a narrow dark brown band across this central yellow band. Scutellum mostly orange-tan, slightly darker at base, with sometimes a dark spot just before apex, extreme apex usually light. Elytra, clavus mottled in fuscous and golden-tan with an oblique white band usually plainly indicated; corium mottled in fuscous and tan, becoming hyaline on apical third, an oblique band across middle, irregularly margined anteriorly and posteriorly with white, this posterior white margin broadening into a distinct white spot on costal border just caudad of middle; explanate costal margin whitish-hyaline, veins at apex, a spot in cell first M_4, and apical callous all dark brown margined with whitish-yellow. Legs ground color golden-yellow, coxa and trochanter of first two pair with a dark spot on cephalic surface, femur with a broad, longitudinal, cephalic brown band, becoming darker near apex, after which there is a white spot, tibia with a dark ring at base, followed by a crescent-shaped white spot or inverted V, rest washed in brown, tarsus tan with tarsa claws dark brown. Hind leg, coxa and trochanter yellowish-tan, femur tan with apical half washed in dark brown, tibia and tarsus light tan or yellow with spines darker tan, and the extreme tip almost black. Mesothorax yellow with a large dark area on each side of labium. Metathorax yellow. Abdomen a light brown, with segments margined in lighter brown or yellow.

Males much darker, but thorax very characteristic with the plain yellow and brown marking, and the band across the yellow portion entirely lacking.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin carinated. Length of eye about one-fourth the width of the head. Ocelli located nearer anterior margin of vertex than pronotum, the distance between the ocelli approximately equal to the distance between each ocellus and eye. Front usually extending beyond vertex as much as the length of the vertex, sometimes only two-thirds of this length. Postclypeus only moderately inflated, arising gradually from face at sides, its length about twice the length of the anteclypeus, and its width about one-third wider than the distance from its lateral margin to outer margin of head. Pronotum deeply and regularly wrinkled, the wrinkles numbering sixteen or seventeen along the median line, the anterior margin of pronotum roundingly produced, lateral margins diverging and posterior margin deeply emarginate. Elytra only slightly inflated, the length of one about three times its width, their surface covered by a moderately fine pubescence; wing venation, cell R_5 longer than wide, cell R_5 much smaller than cell first M_4, the apical callous very prominent, occupying all of cell R_1.

External genitalia: Pygofer of female, length equal to width, exceeded by ovipositor approximately one-sixth of length of latter; male pygofer, its width greater than length, the laterocaudal angles greatly elongated to form two slender ventrad-curving processes, genital plates broad at base, divided along inner margin for half their length, the mediocaudal angles bluntly rounded, exceeded by genital styles for half their length.

Internal genitalia: Lateral valve of ovipositor broad and spoon-shaped, tapering to a bluntly pointed apex, its laterobasal half membranous, ninth sternite somewhat longer than half the length of the valve; middle valve flat and bladelike, the base greatly expanded, then constricted, from whence it tapers to a slender apex; inner valve flat and bladelike, their margins united for over half their length, the free apical inner margins bearing two notches, the first and less prominent one at point of union of the two valves, and the second at base of apical third, these inner margins also bearing fine teeth, numbering ninety-eight to a hundred.

Male styles, basal one-half broad, its lateral margins expanded and bent together, the apical third slender, with the extreme apical portion bent laterad and tapering to a pointed apex. The connective, width about twice its length, roughly triangular; œdagus a broad, straight rod, the apical half usually curving dorsad bearing two lateral broad, membranous flaps.

COMPARATIVE NOTES. See the discussion of these species under this heading in the description of *C. ovata*.

DISTRIBUTION. This species has been described from fourteen specimens, all of which were taken in Siskiyou county, California, except two specimens which were taken from Los Angeles county, California. Of these fourteen specimens six were females and eight were males. These specimens bear no collector's labels.

LOCATION OF TYPES. Holotype and allotype in the National Museum collection, Washington, D. C.

HOST PLANTS. Unknown.

Clastoptera arborina Ball.

(Plates III, VII, XI, XV, XIX, XXIII, XXIV, XXVII.)

Clastoptera obtusa var. *arborina* Ball. Ball, E. D. Can. Ent. LIX; 1927.

ORIGINAL DESCRIPTION.

Size and form of *juniperina* with its testaceous color and black markings. The elytra are washed with smoky with a definite white band running obliquely from the scutellum to the apex of the black line and down it to the costa. Smaller than *obtusa*, with the three transverse reddish-brown bands on vertex and pronotum. Holotype female, allotype male and two paratype females taken by the author on white cedar at Muscatine, Iowa.

WRITER'S DESCRIPTION.

SIZE. Length: ♀ 3.3 mm. to 4.1 mm; ♂ 3.15 mm. to 3 75 mm. Width: ♀ 1.8 mm. to 2 1 mm.; ♂ 1.65 mm. to 2.1 mm.

SHAPE. A small, slender species with the front greatly extended beyond vertex in comparison to rest of body.

COLOR. A conspicuously marked drab tan and brownish species. Head, front yellow with three or four pairs of brownish arcs visible from above, vertex yellowish-tan. with anterior margin reddish-brown. Eyes brown or tannish. Pronotum yellow with anterior margin reddish-brown, a prominent dark band setting off the anterior third, this band darker on the sides than through the middle, the area between this band and the anterior band lighter yellow than the portion posterior to it. Face light yellow, the postclypeus with eight or nine pairs of very dark, distinct brown arcs on anterior two-thirds, the posterior three or four pairs united to form a solid dark brown band which usually does not quite reach the lateral margins; the antennal sockets, a dark spot on gena laterad of transverse band, and the area posterior to eye dark brown. Scutellum yellow, with a brown band at base and usually a dark spot on apex. Elytra mottled in cream-yellow, tan and fuscous, the clavus usually with a cream-colored spot on laterobasal angle and an oblique, irregular light band across middle, with the space between these two spots darker than the remainder of the clavus; corium tannish-fuscous with the explanate costal margin and distal third clear hyaline, an oblique dark brown band across middle, bordered in cream anteriorly and posteriorly, the posterior cream margin becoming a large spot on costal margin, with a dark spot posterior to this, the apical callous and veins dark brown margined in yellow. Legs yellow with tarsus washed in dark brown, the tarsal claws and spines almost black, occasionally faint indications of spots on coxæ and longitudinal stripes on femora and tibiæ. Mesothorax very dark brown. Metathorax and abdomen yellow with the ovipositor very dark brown.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin carinated, front extended beyond vertex as much as the length of vertex itself.

The eyes level with vertex, the length of each being about one-fourth the width of the head. Ocelli located an equal distance between anterior and posterior margins of vertex, the distance between the ocelli being less than the distance between each ocellus and eye. Face, postclypeus moderately inflated, not as flat as in *obtusa* group, its length not quite three times the length of the anteclypeus, its width greater than the space between its lateral margin and the outer margin of the head. Pronotum finely and not deeply wrinkled, the wrinkles numbering about twenty along the median line, its anterior margin very roundingly angulate, its lateral margins short and only slightly diverging, the posterior margin deeply emarginate. Scutellum, width about two-thirds of its length. Elytra moderately inflated, the margins subparallel, the length of one about three times its width, the surface of the elytra covered by a fine, short pubescence. Wing venation, cell R_5 about square, cell R_3 smaller than cell first M_4, the apical callous conspicuous, roughly diamond-shaped, not occupying all of cell R_1.

External genitalia: Pygofer of female, length and width about equal, exceeded by ovipositor by about one-fifth length of latter. Male pygofer considerably wider than long, its lateroventral angles greatly elongated to form slender, tapering processes, the genital styles separated for over half their length, mesocaudal angles bluntly rounded, the plates exceeded by the genital styles for half their length.

Internal genitalia: Lateral valve of ovipositor broad and spoon-shaped with bluntly rounded apex, the ninth sternite small, approximately one-half as long as the valve; middle valves flat and bladelike, tapering to pointed apices and broad at base; inner valves short, broad, bladelike, their inner margins united for about one-third their length, the free apical margins bearing two notches, the first at point of union of the two valves, the other at base of apical third, the space between the notches and also between the second notch and apex broken up into very distinct teeth, numbering eighty-one to ninety.

COMPARATIVE NOTES. There are five species which resemble each other very closely, namely, *C. arborina*, *C. juniperina*, *C. media*, *C. newporta* and *C. texana*. They can be distinguished from each other, however, in several ways. *Texana* can be distinguished from all the others by its large size, which approximates that of the *elongata* group rather than this group. Moreover, it is like the *elongata* group in that the front extends very little beyond the vertex. Then, too, it has a much broader head and pronotum than any of the other four species have. But, although it has the color pattern of the *arborina* group and the size and shape of the *elongata* group, the male genitalia is of the *obtusa* type with the apex divided into sharp points in place of the one.

Juniperina is next in size to *texana*, some of the larger specimens being almost as large as those of *texana*, although some are much smaller. This species can be easily distinguished, however, from the other four by its color. In *juniperina* the head and pronotum are usually a solid golden-yellow with only occasionally a faint indication of a transverse brown band. Moreover, the head is distinctly more pointed than in any of the other species, and the wrinkles on the pronotum are much deeper, with the grooves between them being much more prominent than in any of the other species.

Clastoptera newporta, *media* and *arborina* are more nearly alike, since they are approximately the same size. They differ, however, in that *C. media* is *more slender than the other two, with the margins of the elytra more distinctly parallel. C. newporta is the broadest, most blunt species of the three, while arborina as a general rule is the smallest. Moreover, in arborina the front proportionately is more extended beyond vertex than in the others. There seems to be no outstanding difference in the wrinkles of these species.*

In color there are several minor differences. The general tone of *newporta* seems to be more golden and light brown with less fuscous than in the others. The yellow band on the pronotum of this species, as well as in *texana* and in *arborina,* stands out very distinctly. In *media* the yellow band and also the brown band following it are more obscure. On the other hand, in *arborina* the brown band on pronotum, especially at the sides, and the other brown markings on elytra and scutellum, are usually very dark, becoming almost black in some specimens, so that they stand out in sharp contrast to the rest of body.

The male genitalia of these species, with the exception of those of *C. texana,* which definitely places it in the *obtusa* group, are of little systematic value except, perhaps, in a relative way. The ovipositors, however, prove to be of considerable value, as can be seen by a glance at the drawings. *Arborina* has a broad, short valve, with the two notches spaced widely apart and bearing distinct teeth, numbering eighty-one to ninety. *C. newporta* has a short, broad valve also, but with the two notches spaced much nearer together and the teeth numbering about eighty-two. *C. media* has a long, slender valve, distinctly narrowed and constricted through middle, with about seventy-eight distinct teeth. *C. texana* has a valve similar to *media,* in that it is constricted through the middle, but has a jagged, irregular edge instead of distinct teeth. The valve in *C. juniperina* is of medium length and width, similar to *newporta,* but differing in that the first notch is very inconspicuous and rounded, sometimes just barely visible, while in *newporta* it is always distinct. The teeth of *juniperina* are much larger than in any of the others, there being between seventy and eighty, although some of the larger specimens sometimes have ninety.

DISTRIBUTION. This species was described by Doctor Ball from four specimens taken at Muscatine, Iowa. In the Snow collection of the University of Kansas there is a large series of this species taken from Taos, Taos county, N. Mex., a fairly large series from Coconino county, Arizona, and a smaller series from Poudre canyon, Colo. A few scattered specimens have been taken from Logan county, Utah, Fort Collins, Colo., Yavapai and Oak Creek canyon, Ariz. Also, Professor Severin sent the writer for study eleven specimens from Interior, S. Dak. In all there were available for study some 170 specimens, of which 82 were females and 95 males.

LOCATION OF TYPES. Holotype and allotype and two paratypes in the collection of Dr. E. D. Ball, Sandford, Fla.

HOSTS. Doctor Ball reports it on white cedar.

Clastoptera juniperina Ball.

(Plates III, VII, XI, XV, XIX, XXII, XXIV, XXVII.)

Clastoptera obtusa var *juniperina* Ball. Ball, E. D. Ia. Acad. Sci. XXVI, 1919.

ORIGINAL DESCRIPTION

Resembling *testacea* in ground color, but with the addition of a definite pattern of narrow dark lines on the nervures of the posterior part of the elytra, a band from the middle of the costa to just before the claval suture slightly irregular and curving around the bulla, a medium-sized callosity, a crescent at the apex of clavus, and usually an arcuated transverse line setting off the anterior third of pronotum, a line at the base of the scutellum and a very small spot at the extreme tip black. Sometimes a brown cloud extends obliquely across the clavus from before the middle of the scutellum towards the dark line in front of the bulla.

Described from four examples from Palisades, Colo., taken by the writer.

This variety occurs only on the red cedar, and has been found in all stages on that tree throughout the mountain regions of Colorado and Utah. The ground color and dark penciling render this globose species an almost perfect mimic of a dried strobile of this tree.

NOTES ON SYNONYMY

In regard to this Doctor Ball (1927) writes: 'This is a clear cut and very distinct variety and would be considered as a species if it were not for a few variable forms and its evident relation to the next variety (*arborina*) which is intermediate between this and typical *obtusa*.'

The writer has dissected and figured the genitalia of both *juniperina* and *arborina*. The male genitalia are not only entirely distinct from *obtusa* but differ from *obtusa* much more than some of the other well known species, such as *xanthocephala*. The ovipositors likewise, are distinctly different. Moreover they are taken out of the *obtusa* group because of the color pattern of the face and the extension of the front.

WRITER'S DESCRIPTION

SIZE. Length ♀ 4.2 mm. to 4.8 mm., ♂ 4.2 mm. Width ♀ 2.4 mm. to 2.7 mm., ♂ 2.4 mm.

SHAPE. A medium-sized ovate species with a decidedly pointed head.

COLOR. A golden-yellow species with dark markings on apex of elytron standing out in sharp contrast. Head, front and vertex usually entirely golden-yellow, eyes golden-tan or brown. Face, postclypeus in some cases entirely yellow with nine or ten pairs of faint arcs, sometimes the posterior arcs fused to form two dark spots sometimes becoming a transverse band, always abbreviated before margins, rest of face all yellow excepting a spot on anteclypeus which may be distinct or very faint. Pronotum usually all yellow, with the anterior margin reddish-tan, and sometimes an indication of a narrow transverse band across the disk. Scutellum yellow, usually a dark band at base and a darker spot at apex, the extreme apical part usually somewhat lighter yellow than the rest. Elytra golden-yellow, clavus usually with a dark cloud on anterior half which is more pronounced in some than in others, its apex bearing a dark arc on the vein just anterior to membrane, corium mottled golden-tan and fuscous, a dark, oblique band across middle bordered anteriorly and posteriorly with cream, the posterior cream border expanding into a large cream spot on costal margin, the apical third of corium hyaline except for the dark brown veins and apical callous, which are in turn margined by cream, the explanate costal margin also light colored. Legs yellow, with last segments of tarsus, the spines on hind tibia and all the tarsal claws very dark brown. Mesothorax yellow, with a large dark brown area on each half which is more pronounced laterad of labium. Metathorax and abdomen yellow with the ovipositor dark brown.

STRUCTURAL DETAILS. Vertex slightly depressed transversely, anterior margin not distinctly carinated. Front extending beyond vertex at least as much as two-thirds of length of vertex. Length of each eye slightly over one-fourth of the total width of head. Ocelli located halfway between anterior and posterior margins of vertex, the distance between the ocelli being about equal to the distance between each ocellus and eye. Postclypeus moderately inflated, more so than in *obtusa* and *testacea,* arising gradually from face at sides, its length about two and one-half times length of the anteclypeus, and its width slightly wider than the distance between its lateral margin and the outer margin of the head. Pronotum deeply and distinctly wrinkled, the wrinkles uniform, numbering eighteen or twenty along median line. Elytra moderately inflated, narrow at base, their margins then slightly diverging until broadest part is just anterior to apex of clavus, the length of one approximately twice its width; wing venation, cell R_5 longer than wide, cell R_3 much smaller than cell first M_4, the apical callous distinct but occupying only the cephalic half of cell R_1, rest of cell somewhat thickened but not darkened.

External genitalia: Pygofer of female somewhat wider than long, exceeded by ovipositor one-fourth of length of latter. Male pygofer broader than long, exceeded by genital styles for one-half their length; genital plates separated on inner margin for half their length, the mediocaudal angle bluntly rounded.

Internal genitalia · Lateral valve of ovipositor broad, spoonshaped, tapering to a bluntly rounding apex, ninth sternite slightly less than half length of valve, middle valve flat, bladelike, tapering to a slender-pointed apex; inner valves, bladelike, long, narrow, united for approximately one-half their length, the free inner margins bearing conspicuous teeth, numbering between seventy and ninety-six and two notches, a gradually sloping one near point of separation of valves, a second distinctly protruding one just anterior to apical fourth.

Male styles much broader at basal two-thirds, their margins greatly expanded and folded together, apical portion more slender, tapering to a pointed, laterad-curving apex. Connective roughly triangular; œdagus a long slender rod with two membranous lateral flaps on apical half.

COMPARATIVE NOTE. See discussion under this heading in the description of *C. arborina* on page 95.

DISTRIBUTION. In regard to the distribution of this species Doctor Ball states the following: "It has been taken by the writer, abundantly in Colorado and Utah and rarely in Montana, the Bad Lands of North Dakota, West Virginia, Washington, D. C., and Woods Hole, Mass." In addition to the states listed above, this species has been taken in Los Angeles county, California, Arizona and Texas.

The writer had on hand for study eight females and six males, so that the distribution of sexes is apparently about equal.

LOCATION OF TYPES. In the collection of Dr. E. D. Ball, Sanford, Fla.

HOSTS. Doctor Ball says that it occurs on red cedar, "where its color and pattern closely resemble the strobile of this tree."

Clastoptera media sp. new.

(Plates III, VII, XI, XV, XIX, XXIII, XXIV, XXVII.)

SIZE. Length: ♀ 3.8 mm. to 4.12 mm.; ♂ 3.57 mm. Width: ♀ 1.9 mm. to 2.2 mm.; ♂ 1.9 mm.

SHAPE. A small, very slender species, with front moderately extended beyond vertex, and margins of elytra parallel.

COLOR. A yellowish-tan and fuscous species, similar in color pattern to *arborina, newporta and juniperina.* Front and vertex golden-tan, with two or three pairs of brownish arcs visible on front, and vertex margined anteriorly with brown. Eyes golden-brown. Face light yellow marked with dark, as follows: Nine pairs of reddish-brown arcs on postclypeus, the posterior three pairs darker, usually united across middle to form a dark blackish-brown spot, a brown spot between postclypeus and eye, a small dark spot in center of anteclypeus, sometimes the area beneath the eye dark brown. Pronotum golden-tan, with a brown band across anterior margin and another across disk. Scutellum brown at base, yellow through middle and apex dark brown. Elytra brownish-tan, clavus with a large light spot on claval suture near base, followed by a large dark fuscous cloud, an irregular whitish-yellow band across middle, a blackish-brown spot at extreme apex; corium, yellow spot near base, explanate costal margin hyaline, an irregular oblique dark-brown band across middle, interrupted before reaching claval suture, partially bordered anteriorly and entirely posterior by cream-yellow, the latter becoming a large cream-yellow spot on costal margin, rest of elytron tannish-hyaline with veins and apical callous dark brown margined in yellow. Legs, coxa and trochanter of first two pairs yellow mottled in brown, femur with two longitudinal bands, one yellow and one brown on cephalic surface, tibia brownish with a narrow yellow longitudinal band; tarsus brown with blackish claws. Hind legs yellow, mottled duly with brown, spines and claws dark brown or black. Mesothorax blackish-brown. Metathorax yellow. Abdomen yellow, ovipositor marked with black.

STRUCTURAL DETAILS. Vertex transversely depressed, anterior margin carinated. Length of each eye more than one-fourth width of head. Front extending beyond vertex a distance equal to length of vertex. Ocelli located nearer anterior margin of head than pronotum, the distance between the ocelli equal to the distance between each ocellus and eye. Postclypeus only slightly inflated, its length nearly three times length of anteclypeus. Pronotum, width one and three-fourths greater than its length, anterior margin roundingly produced, lateral margins greatly diverging, posterior margin deeply emarginate, its surface crossed by many semideep wrinkles, numbering seventeen along median line. Scutellum approximately one and one-half times its width. Elytra scarcely inflated, base of costal margin only slightly flaring, then parallel-margined to apical third of elytron, from whence it tapers to a pointed apex, covered by a median fine pubescence. Wing venation, cell R_5 longer than wide, cell R_3 considerably smaller than cell first M_4, apical callous roughly diamond-shaped, occupying only part of cell R_1.

External genitalia: Pygofer of female slightly longer than wide, exceeded by ovipositor by about one-sixth of length of latter. Male genital plates broad at base, inner margins rounding to a blunt apex, exceeded by genital plates about one-half their length.

Internal genitalia: Lateral valve of ovipositor broad, spoon-shaped, ninth sternite approximately three-fourths length of valve; inner valves flat, blade-like, united on inner margins foı almost half their length, the free margins bearing numerous distinct teeth, approximately seventy-eight, the valves narrowed through middle, then expanding to form a slight rounded notch, another protruding notch at base of approximate apical third. Male styles broad at base with the margins bent together, apical third greatly narrowed, tapering to a slender laterad-curving apex.

COMPARATIVE NOTES. See discussion under this heading in the description of *Clastoptera arborina.*

DISTRIBUTION. Described from five females and one male specimen, collected in Oak Creek canyon, Arizona, by Dr. R. H. Beamer.

LOCATION OF TYPES. Allotype and holotype in Snow collection, University of Kansas.

Clastoptera newporta sp. new.

(Plates III, VII, XI, XV, XIX, XXIII, XXIV, XXVII.)

SIZE. Length: ♀ 3.3 mm. to 4.1 mm.; ♂ 3.3 mm. to 4.01 mm. Width: ♀ 1.9 mm. to 2.36 mm.; ♂ 2.03 mm. to 2.2 mm.

SHAPE. A short, bluntly robust species with the front greatly extended and margins of elytra subparallel.

COLOR. A yellowish-tan and fuscous species, very similar in color pattern to *arborina* and *media*. Front golden-tan with two or three pairs of brownish arcs, vertex golden-tan with anterior margin narrowly bordered in light brown. Eyes grayish-tan. Face light or dirty yellow, marked as follows: A blackish-brown band across middle third of postclypeus, sometimes interrupted at sides and preceded anteriorly by five or six pairs of blackish-brown arcs, a dark spot on gena between transverse band and eye, antennal sockets and central spot on anteclypeus dark brown. Pronotum bordered anteriorly by a brown band which is broadest through middle, followed by a yellow band, then a somewhat narrower brown band which is sometimes much darker on sides than through middle, rest dusky-tan through middle. Elytra, clavus with a large, light spot on claval suture near base, followed by a large dark fuscous cloud, an irregular yellow band across middle, rest tannish-fuscous with a dark-brown spot on apex; corium, a yellow spot near base, explanate costal margin hyaline and irregular, oblique dark band across middle of corium, partially bordered anteriorly and entirely posteriorly by yellow, which becomes a large yellow spot on costal margin, followed by a smaller dark spot and a brown cloud just before inflated part of elytron, rest tannish-hyaline with veins and apical callous dark brown, margined in opaque yellow. Legs, coxa of first two pairs dark brown, trochanter brown with yellow margin, femur yellow with a longitudinal brown band on cephalic surface, interrupted before base at apex, tibia yellow with a longitudinal light-brown band, tarsus brownish with black claws. Hind legs mostly yellow, washed in light brown, tips of spines and claws black. Mesothorax dark brown through middle, yellow at sides. Metathorax yellow. Abdomen all yellow, or with segments sometimes darker through the middle, ovipositor and genital plates dark.

STRUCTURAL DETAILS. Vertex transversely depressed, anterior margin distinctly carinated. Width of the head about three and one-half times the length of one eye. Front extending beyond vertex as much as length of vertex. Ocelli located much nearer anterior margin of vertex than pronotum; the distance between the ocelli equal to or slightly less than the distance between each ocellus and eye. Postclypeus moderately inflated, its length three times the length of the anteclypeus. Pronotum almost twice as wide as long, anterior margin roundingly produced, posterior margin deeply emarginate, lateral margins diverging, the disk crossed by semideep wrinkles, numbering about nineteen or twenty along median line. Scutellum, length about one and one-half times its width. Elytra slightly inflated, the length of one either two or two and one-half times its width, base of costal margin only slightly flaring, then almost parallel-margined to apical third of elytra, from whence it abruptly tapers to a blunt apex. Wing venation, cell R_5 longer than wide, cell R_3 considerably smaller than cell first M_4, apical callous usually long and narrow occupying the dorsal half of cell R_1.

External genitalia: Pygofer of female slightly wider than long, exceeded by ovipositor about one-sixth of length of latter. Male genital plates broad at base, their inner margins rounding to a blunt apex, exceeded by genital styles for about one-half their length.

Internal genitalia: Lateral valve broad, spoon-shaped, its dorsobasal margin membranous for half its length, ninth sternite two-thirds the length of the valve; inner valve flat, bladelike, their dorsal margins united for almost half their length, the free margins bearing two notches, one at a point of union of the valves and the other at the base of the apical third, the free margin between first notch and apex of valve broken up into large, sharply pointed teeth, numbering about eighty-two. Genital styles broad at base, their lateral margins folded together, apical third greatly narrowed, tapering to a laterad-curving, sharply pointed apex; connective roughly triangular, œdagus a slender rod with apical portion curving dorsad and bearing a large membranous flap on each side.

COMPARATIVE NOTES. See discussion under this heading in description of *C. arborina.*

DISTRIBUTION. This is an eastern species apparently. Specimens have been collected from Connecticut by Uhler; Lakehurst, N. J., by E. L. Dickerson; Lake George, New York, by J. L. Zabriskie; and Newport, R. I., by Uhler.

The species was described from six females and five males.

LOCATION OF TYPES. Holotype male, and allotype female, American Museum of Natural History.

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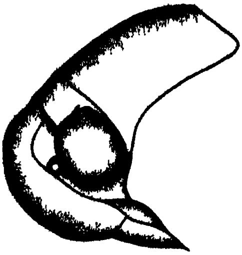
EXPLANATION OF PLATES.

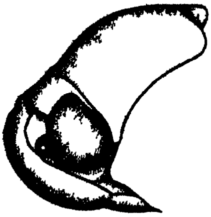
PLATE III.

FIGS 1 to 13 Lateral view of head

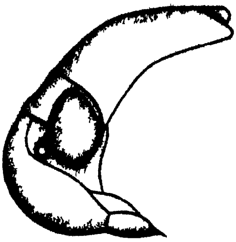
PLATE III.



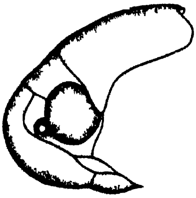
1 C delicata



2 C lineatollis
C brunnea
C binotata



3 C sierra



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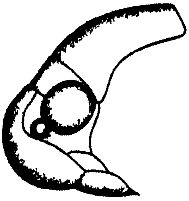
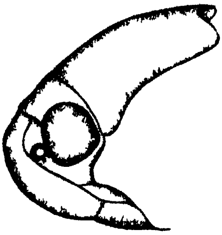
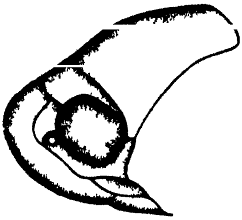


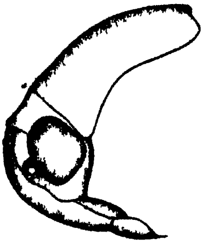
4 C saint-cyri
C hyperici



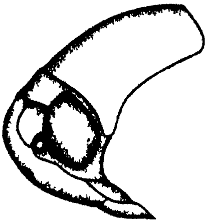
6 C salicis



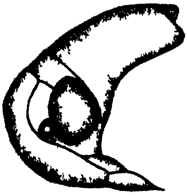
8 C disdincta



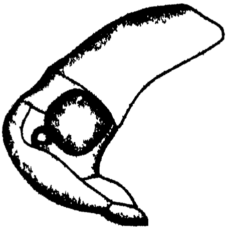
7 C obtusa
C xanthocephala
C osborni
C testacea
C achatina

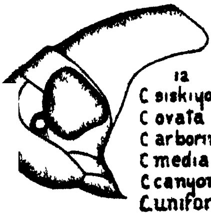


9 C lawsoni

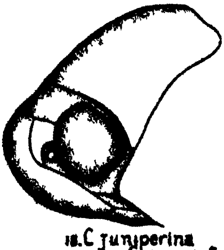


10 C arizonana





12
C siskiyou
C ovata
C arborina
C media
C canyonensis
C uniformis



13 C juniperina
C newporti

PLATE IV.

FIG. 1. Ventral view of head. Typical *delicata* type.

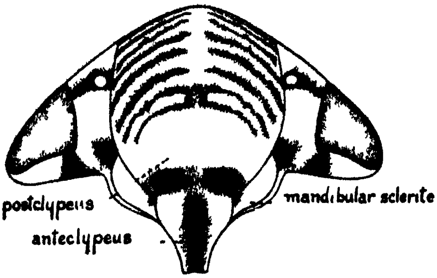
FIG. 1*a*. Ventral view of head. Only occasional specimens of this type.

FIG. 2. Ventral view of head. Typical *lineatocollis* type for females and light colored males.

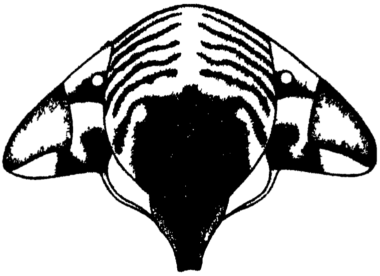
FIG. 2*a* Ventral view of head. Typical type for black males.

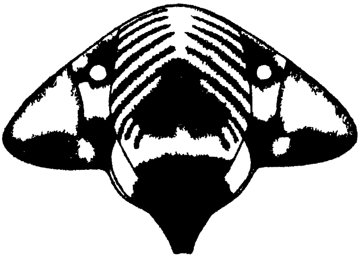
FIGS. 3 to 6. Ventral view of head. Typical type.

PLATE IV

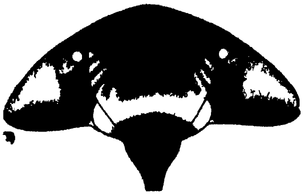


1 C delicata

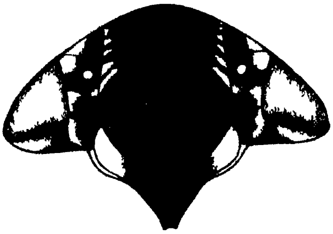




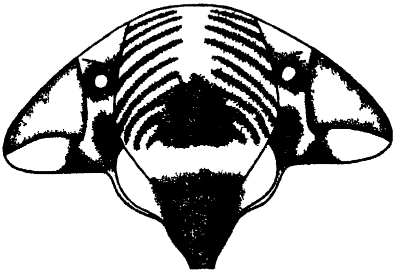
2 C lineatocollis



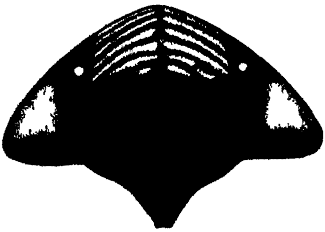
2a -Black male



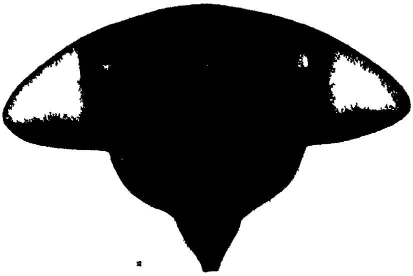
3 C brunnea



4 C lugubris



5 C binotata

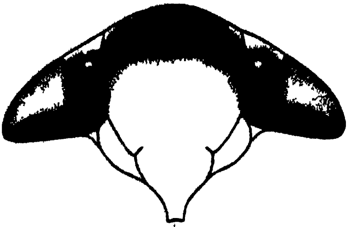


6 C sierra

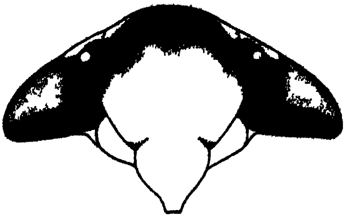
PLATE V.

FIG. 1. Ventral view of head.
FIG. 1*b*. Ventral view of head. Variation from typical type.
FIGS. 2 to 9. Ventral view of head.

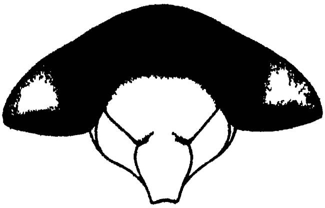
PLATE V.



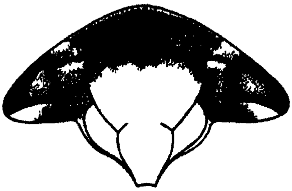
1 C.salicis



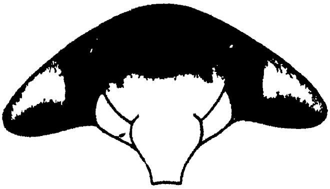
1b



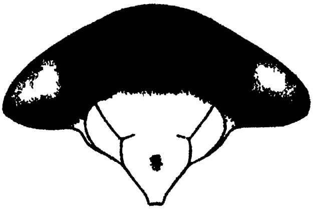
2 C.proteus var nigricollis



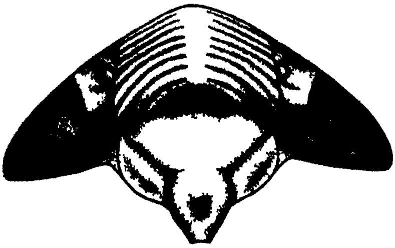
3 C proteus



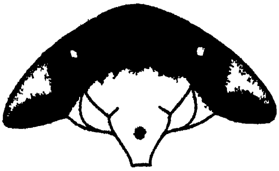
4 C.saint-cyri var anceps



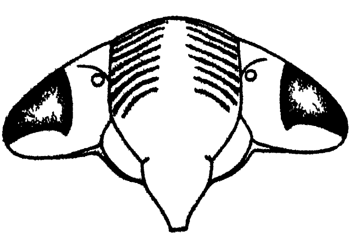
5 C saint-cyri



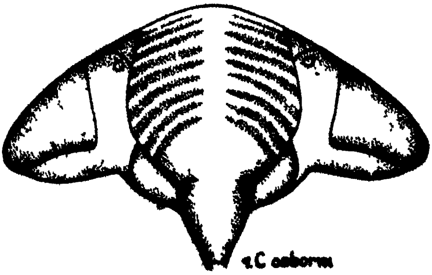
6.C distincta



7 C.hyperici



8.C.testacea



9.C osborni

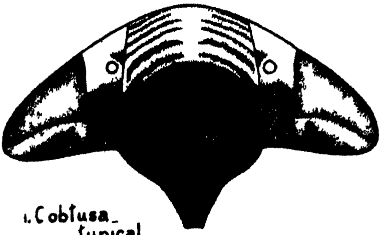
PLATE VI

FIG 1 Ventral view of head

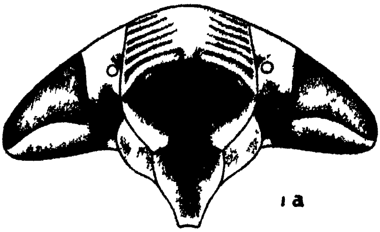
FIG 2 Ventral view of head Occasional forms.

FIGS 1 to 8 Ventral view of head Typical forms

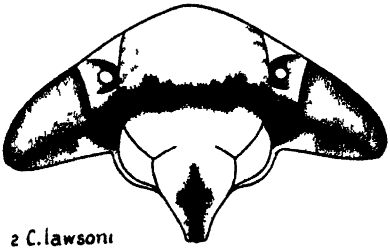
PLATE VI.



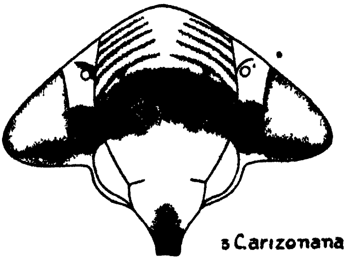
1. C obtusa - typical -



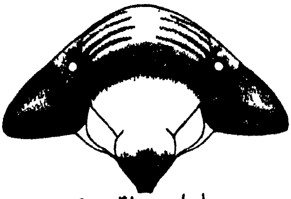
1 a



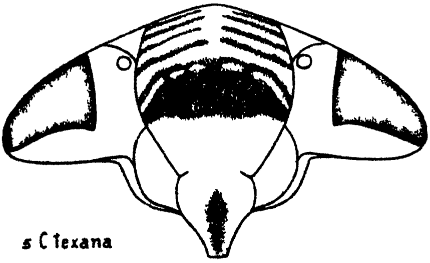
2 C. lawsoni



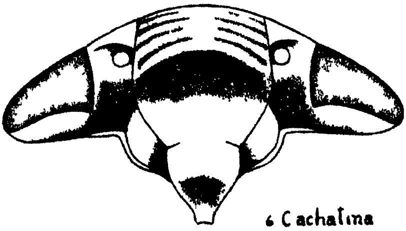
3 C. arizonana



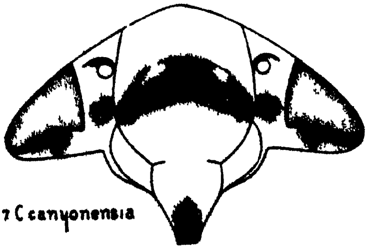
4 C xanthocephala



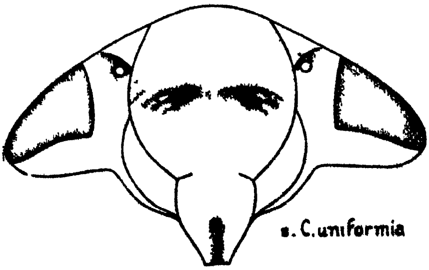
5 C texana



6 C achatina



7 C canyonensis

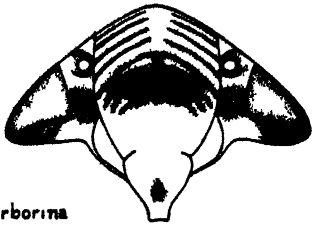


8. C. uniformis

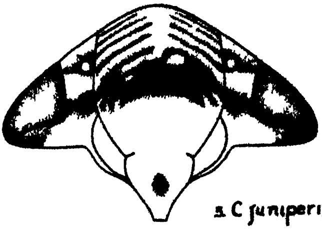
PLATE VII.

FIGS 1 to 9 Ventral view of head. Typical forms.

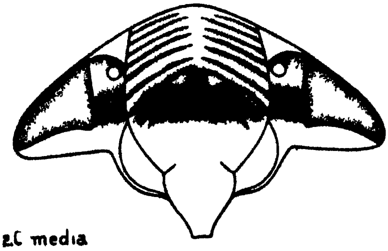
PLATE VII.



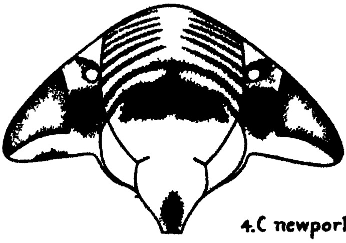
1 C arborina



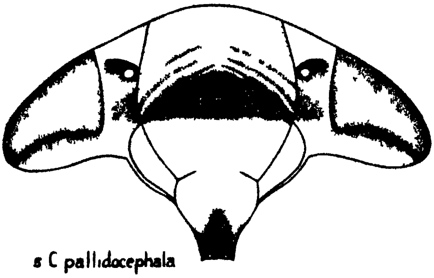
3 C juniperina



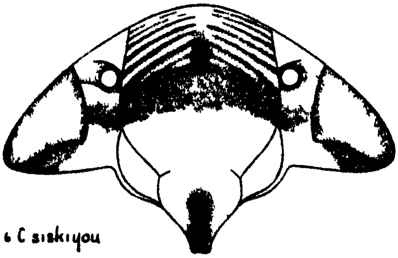
2 C media



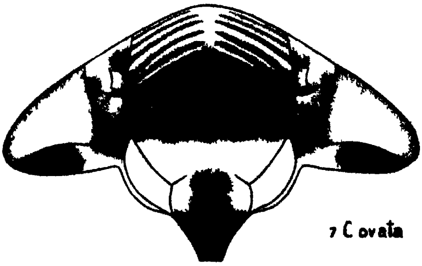
4.C newporta



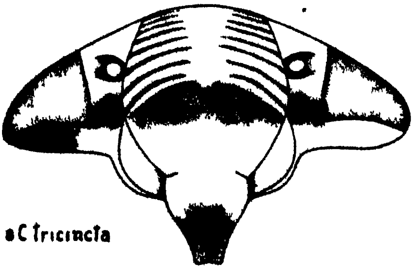
5 C pallidocephala



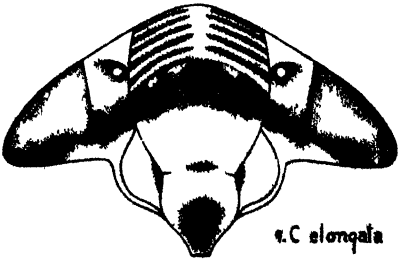
6 C siskiyou



7 C ovata



8 C tricincta

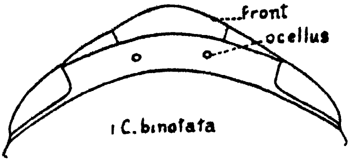


9.C elongata

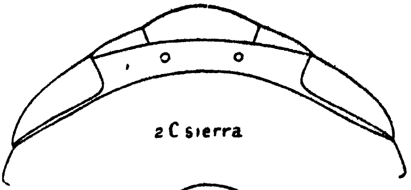
PLATE VIII.

FIGS. 1 to 6 Dorsal view of head.
FIGS. 7 to 12. Dorsal view of pronotum.

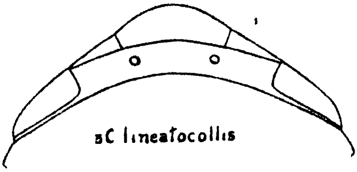
PLATE VIII.



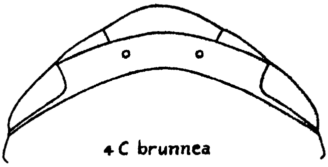
1 C. binotata



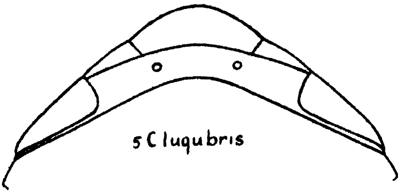
2 C sierra



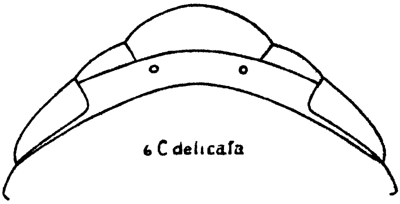
3 C lineatocollis



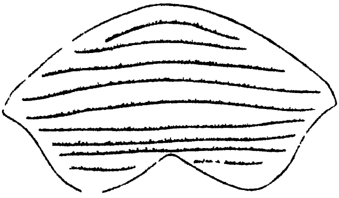
4 C brunnea



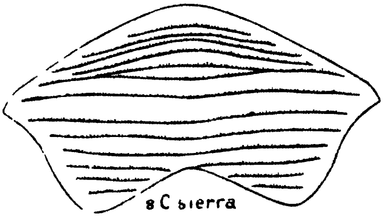
5 C luqubris



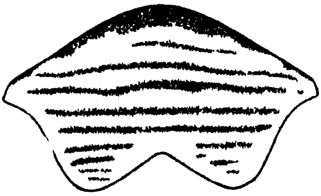
6 C delicata



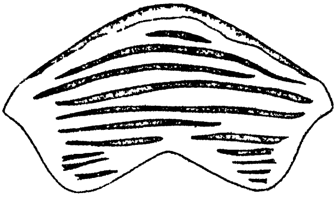
7 C binotata



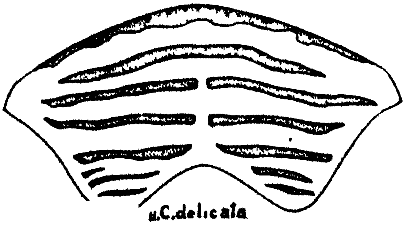
8 C sierra



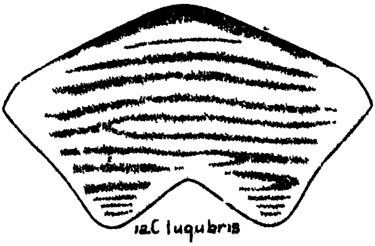
9 C brunnea



10 C lineatocollis



11 C. delicata

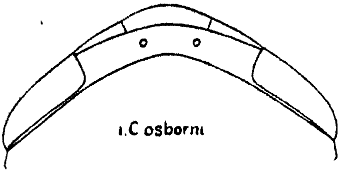


12 C luqubris

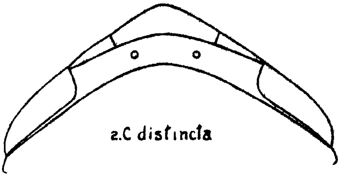
PLATE IX.

FIGS 1 to 5 Dorsal view of head.
FIGS 6 to 12 Dorsal view of pronotum.

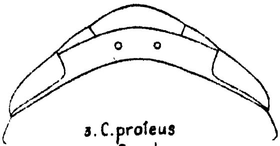
PLATE IX.



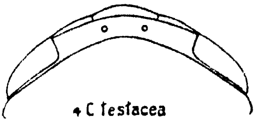
1. C osborni



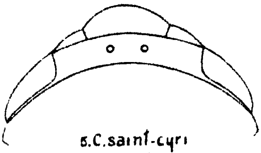
2. C distincta



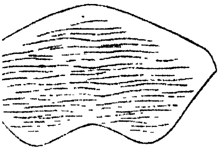
3. C. proteus
C. salicis



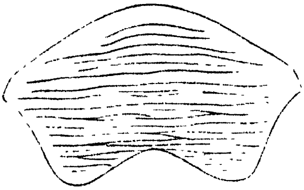
4 C testacea



5. C. saint-cyri
C hyperici

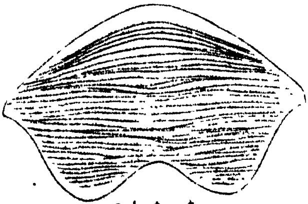


6 C hyp

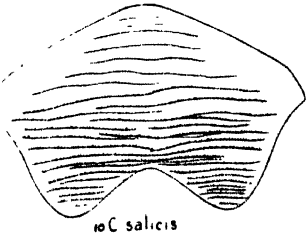


7 C saint-cyri

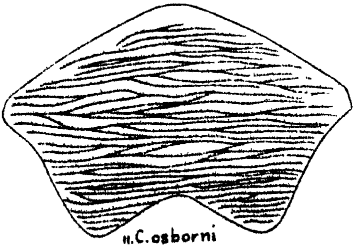
8 C. proteus



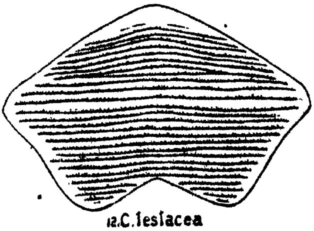
9 C. distincta



10 C salicis



11. C. osborni



12. C. testacea

PLATE X.

FIGS 1 to 8 Dorsal view of head.
FIGS 9 to 16 Dorsal view of pronotum, showing wrinkles

PLATE X.

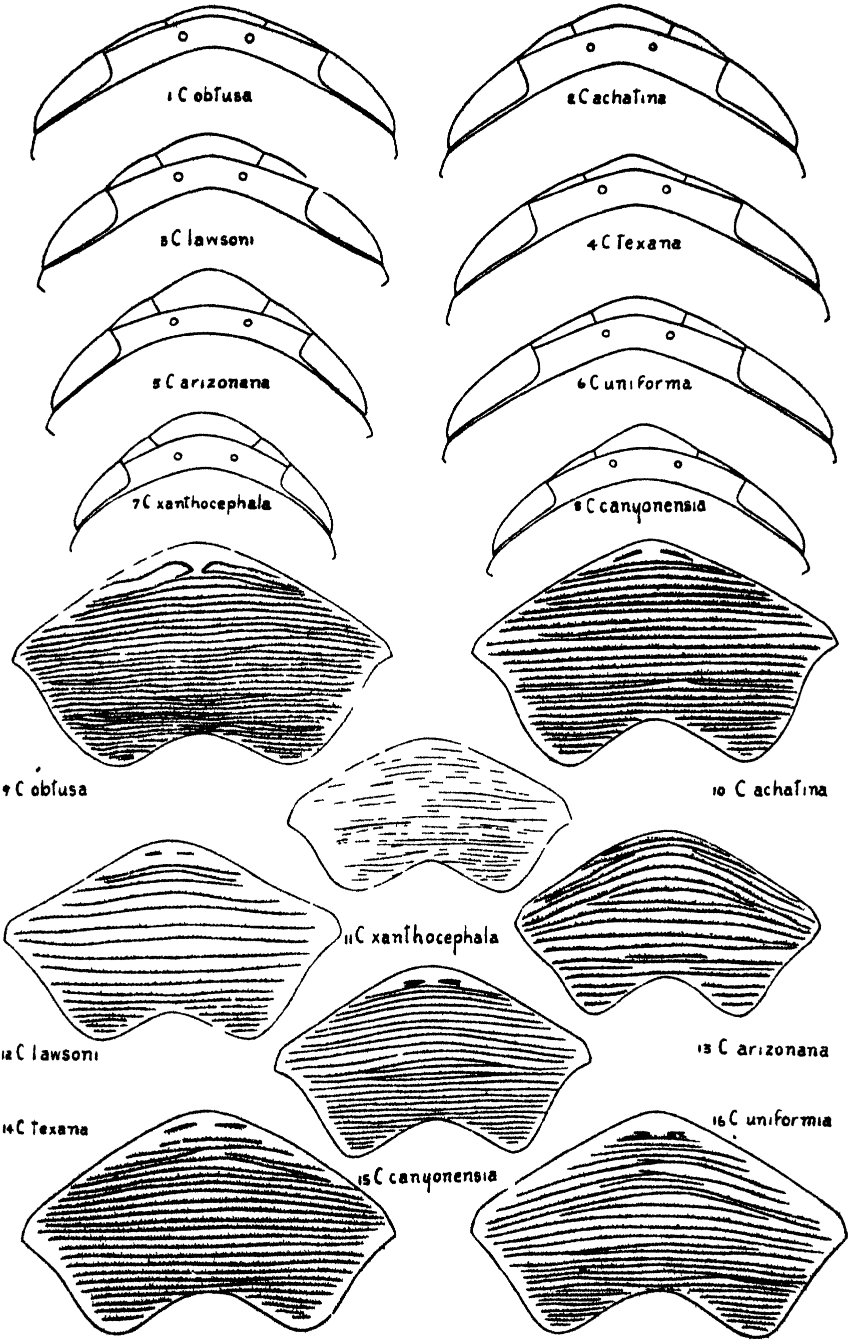
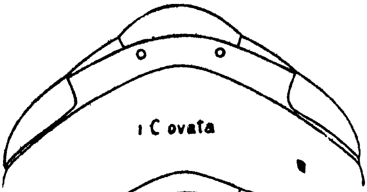

1 C obtusa
2 C achatina
3 C lawsoni
4 C texana
5 C arizonana
6 C uniforma
7 C xanthocephala
8 C canyonensis
9 C obtusa
10 C achatina
11 C xanthocephala
12 C lawsoni
13 C arizonana
14 C texana
15 C canyonensis
16 C uniformia

PLATE XI.

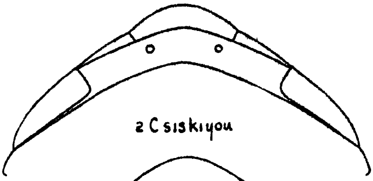
FIGS. 1 to 7. Dorsal view of head

FIGS. 8 to 15. Dorsal view of pronotum, showing wrinkles.

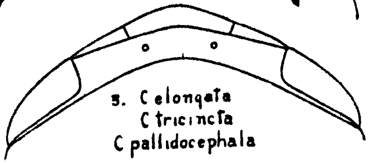
PLATE XI.



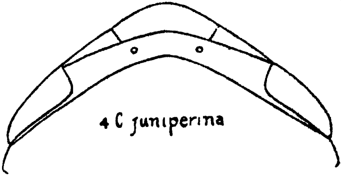
1 C ovata



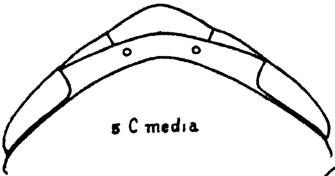
2 C siskiyou



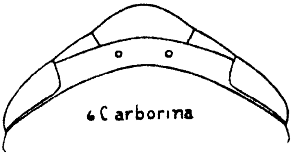
3. C elongata
C tricincta
C pallidocephala



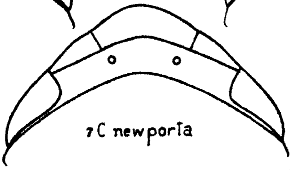
4 C juniperina



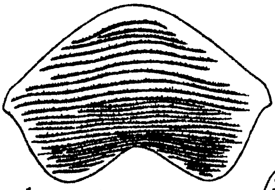
5 C media



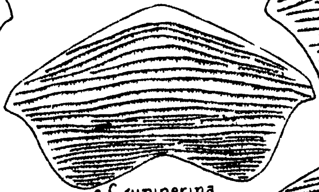
6 C arborina



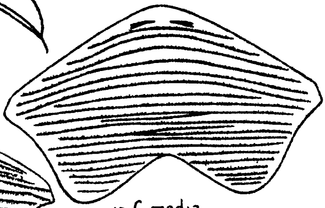
7 C newporta



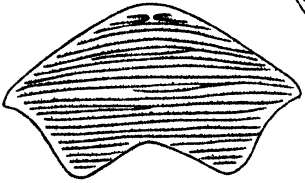
8. C arborina



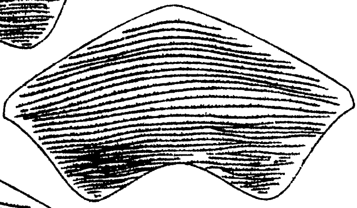
9 C juniperina



10 C media

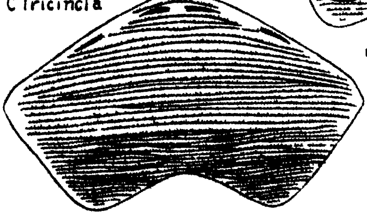


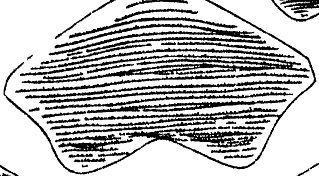
11 C newporta



12 C ovata

13 C pallidocephala
C tricincta





14 C elongata

15. C siskiyou

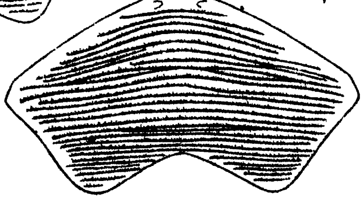
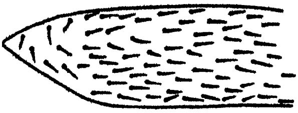


PLATE XII.

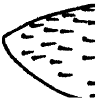
FIGS. 1 to 6. Apex of clavus of elytron, showing distribution of hairs.
FIGS. 7 to 12. Elytron, drawn from microscope slide.

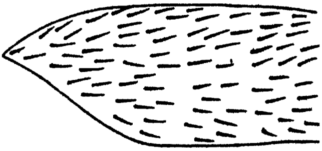
PLATE XII.



1. C lineatocollis

2. C. luqubris



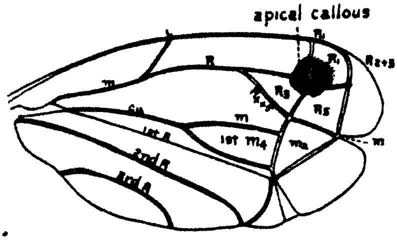


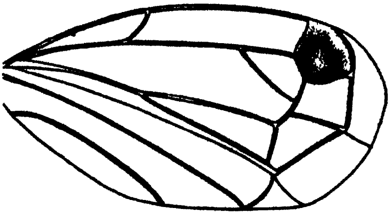
3. C brunnea

4. C. delicata

5. C binotata

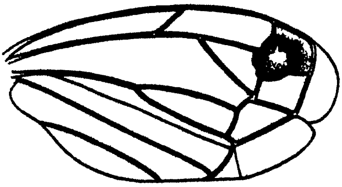
6. C. sierra

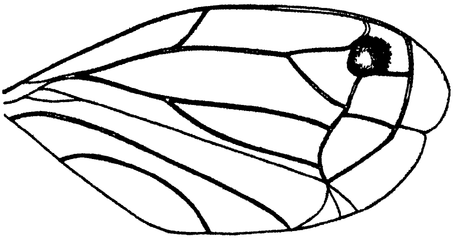




7 C lineatocollis

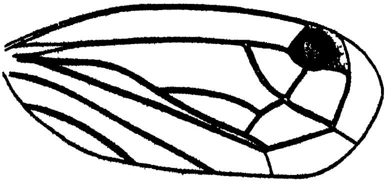
8 C luqubris

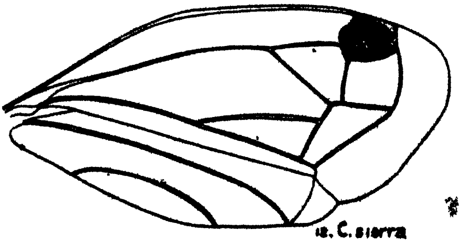




9. C brunnea

10. C delicata





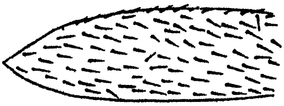
11. C. binotata

12. C. sierra

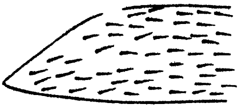
PLATE XIII.

FIGS 1 to 7. Apex of clavus of elytron, showing distribution of hairs.
FIGS. 8 to 14. Elytron, drawn from microscope slide.

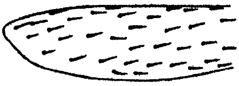
PLATE XIII



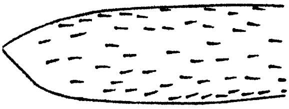
1 C testacea



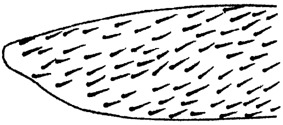
2 C distincta



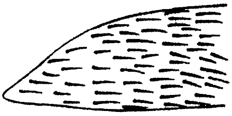
3 C saint-cyri



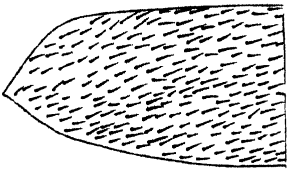
4 C proteus



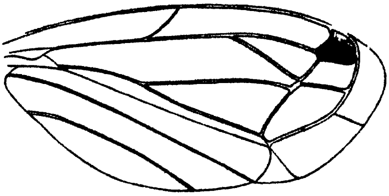
5 C salicis



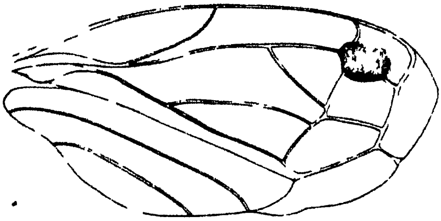
6 C hyperici



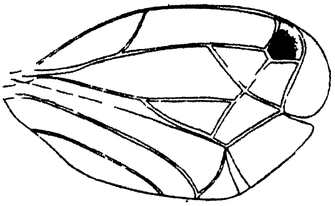
7 C osborni



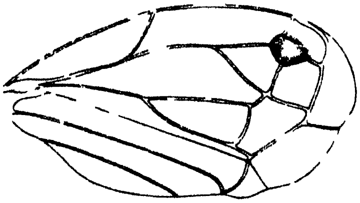
8 C testacea



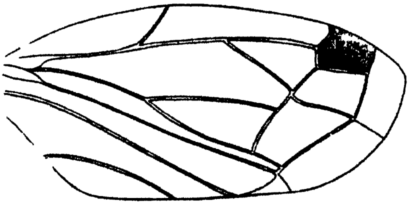
9 C salicis



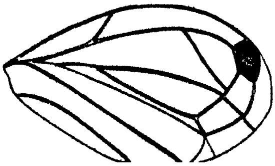
10 C saint-cyri



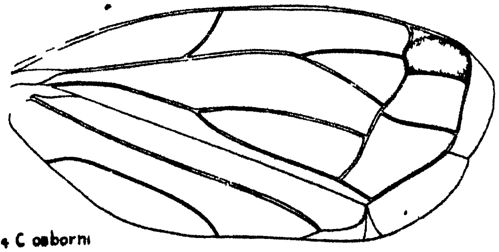
11 C proteus



12 C distincta



13 C hyperici

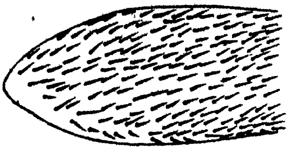


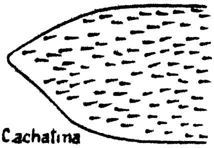
14 C osborni

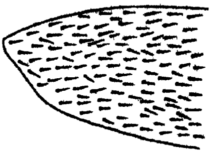
PLATE XIV.

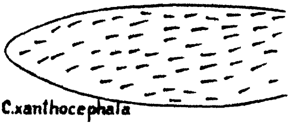
FIGS. 1 to 8. Apex of clavus of elytron, showing distribution of hairs.
FIGS. 9 to 16. Elytron, drawn from microscope slide.

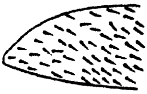
PLATE XIV.

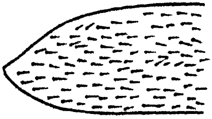

1. C. obtusa

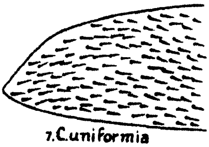

2. C. achatina

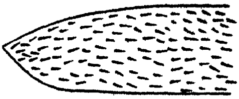

3. C. lawsoni

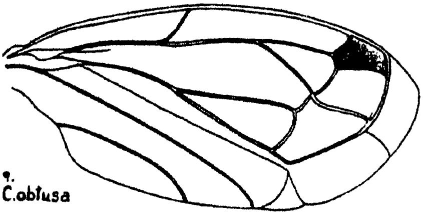

4. C. xanthocephala

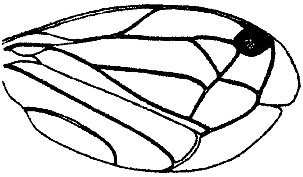

5. C. arizonana

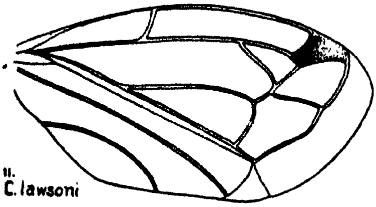

6. C. texana

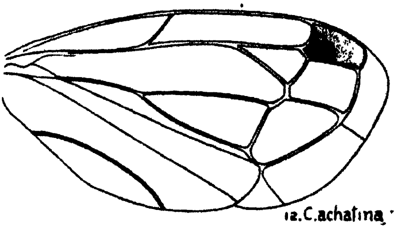

7. C. uniformia

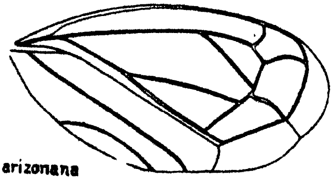

8. C. canyonensia

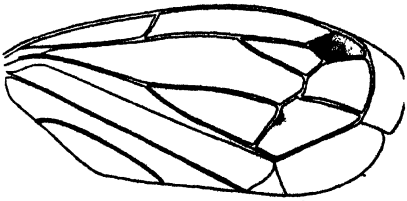

9. C. obtusa

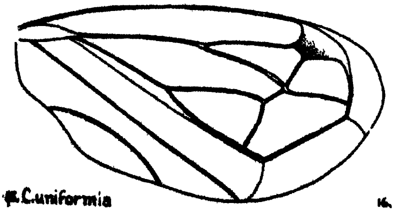

10. C. xanthocephala


11. C. lawsoni


12. C. achatina


13. C. arizonana


14. C. texana


15. C. uniformia

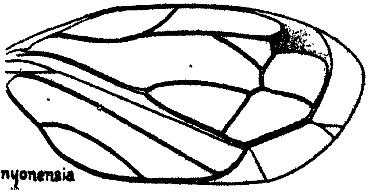

16. C. canyonensia

PLATE XV.

FIGS. 1 to 9. Apex of clavus of elytron, showing distribution of hairs.
FIGS. 10 to 18. Elytron, drawn from microscope slide.

PLATE XV

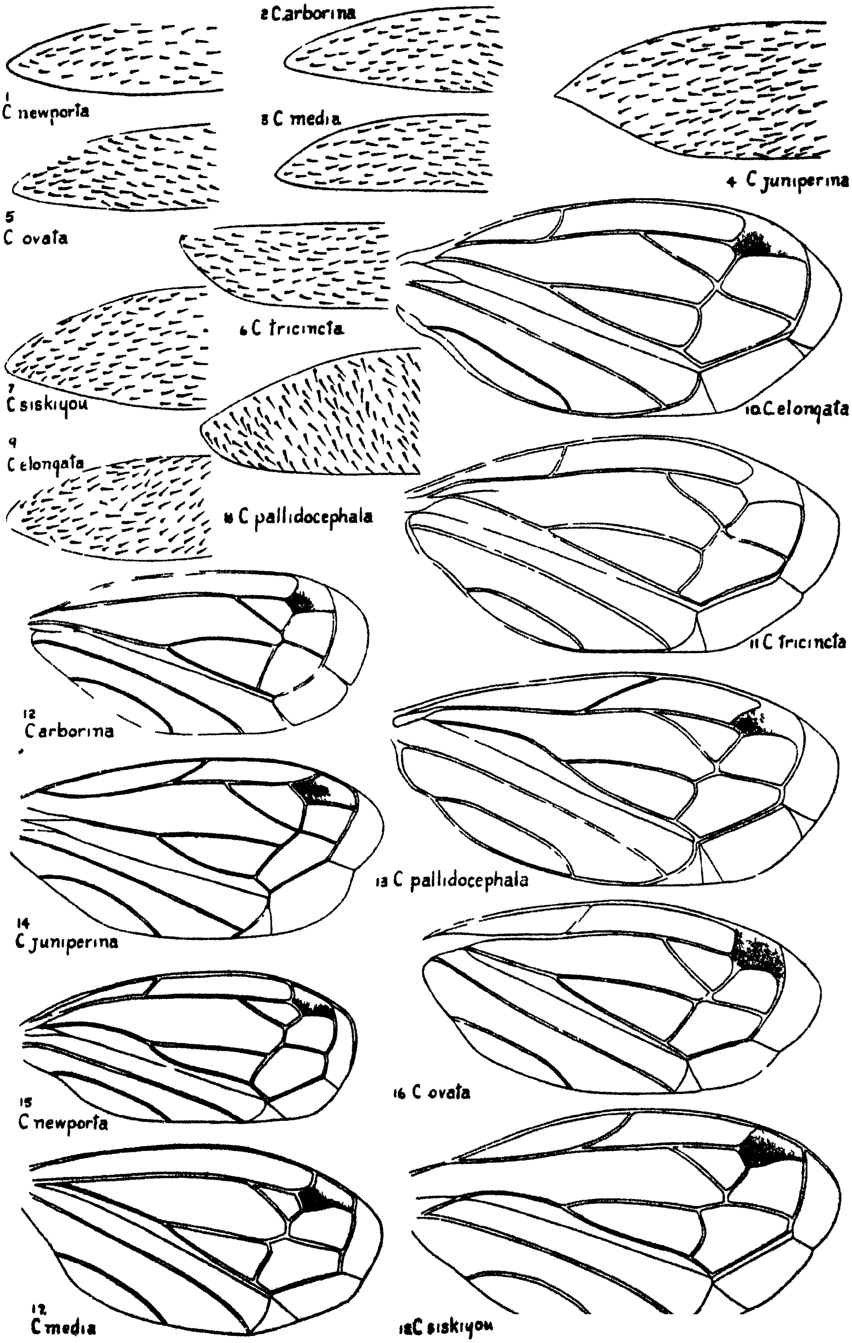
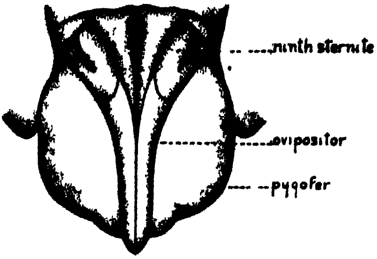

1 C newporta
2 C arborina
3 C media
4 C juniperina
5 C ovata
6 C tricincta
7 C siskiyou
8 C pallidocephala
9 C elongata
10 C elongata
11 C tricincta
12 C arborina
13 C pallidocephala
14 C juniperina
15 C newporta
16 C ovata
17 C media
18 C siskiyou

PLATE XVI.

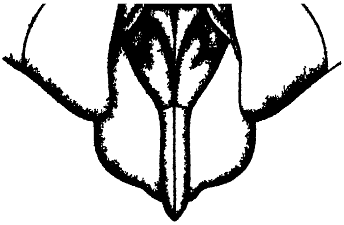
FIGS 1, 2, 3, 4 6 Ventral view of female pygofer, drawn from a specimen relaxed in boiling water

FIG 5 Ventral view of female pygofer, drawn from unrelaxed specimen

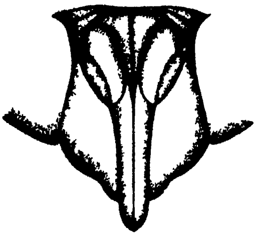
PLATE XVI.



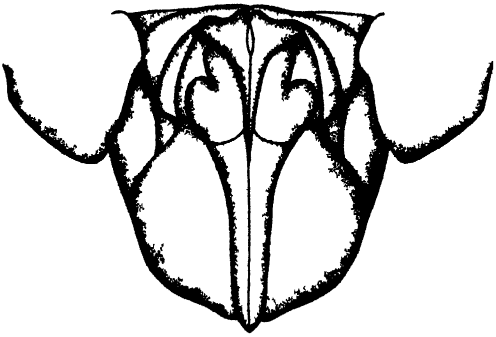
1 C lugubris



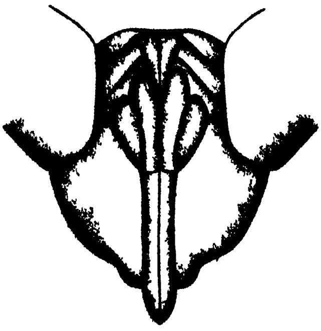
2 C lineatocollis



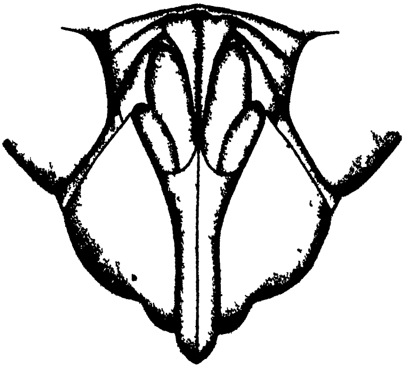
3 C bru



4 C binotata



5 C sierra

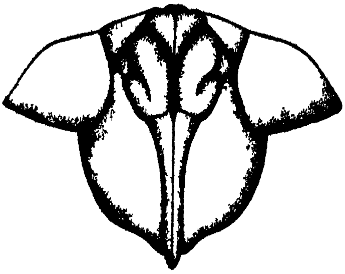


6 C delicata

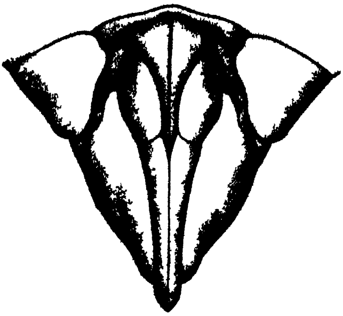
PLATE XVII.

FIGS. 1 to 7. Ventral view of female pygofer, drawn from a specimen relaxed in boiling water.

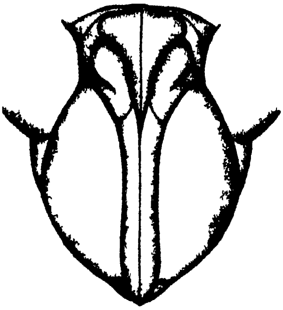
PLATE XVII.



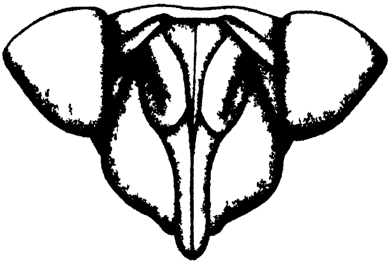
1 C testacea



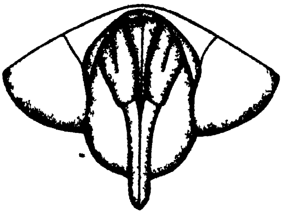
2 C osborni



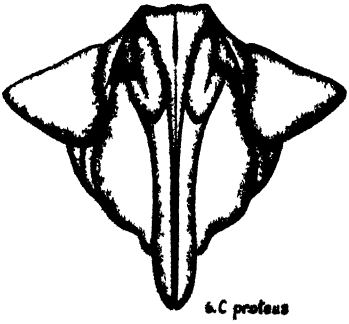
3 C distincta



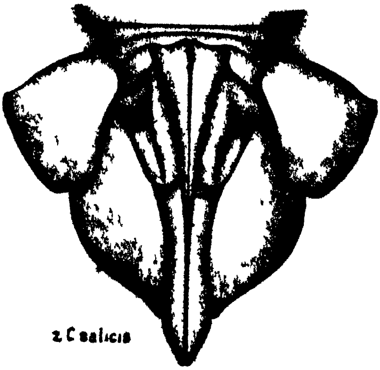
4 C saint-cyri



5 C hyperici



6 C proteus

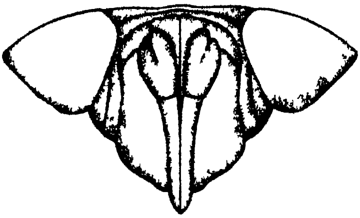


7 C salicis

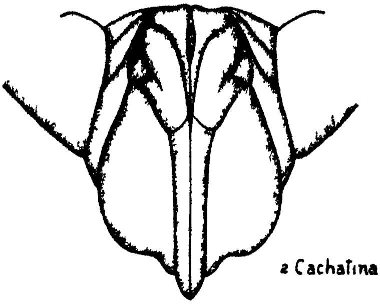
PLATE XVIII.

FIGS. 1 to 8. Ventral view of female pygofer, drawn from a specimen relaxed in boiling water

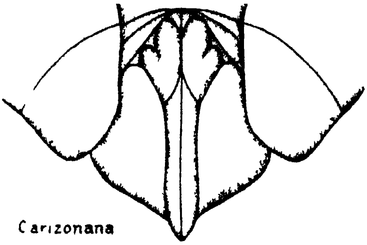
PLATE XVIII



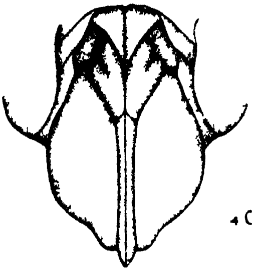
1 xanthocepha



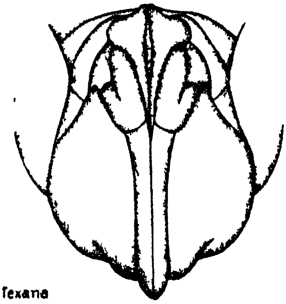
2 C achatina



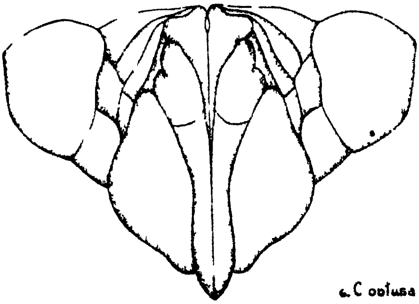
C arizonana



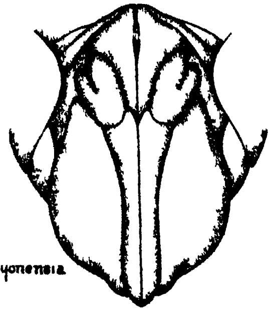
4 C lawson



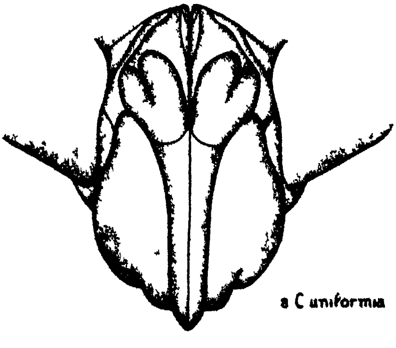
5 C texana



6 C obtusa



7 C canyonensis

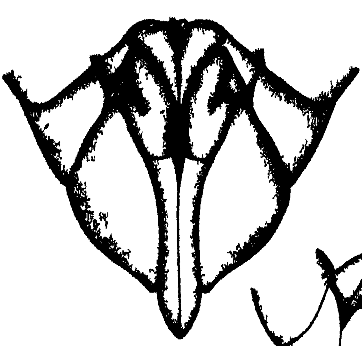


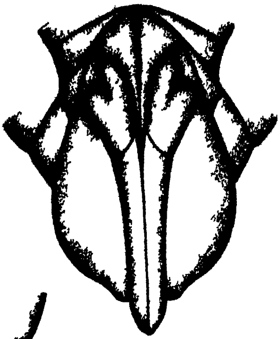
8 C uniformis

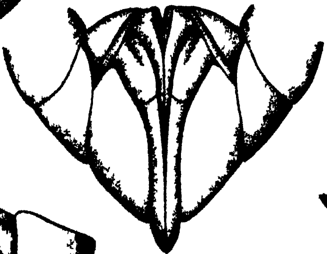
PLATE XIX.

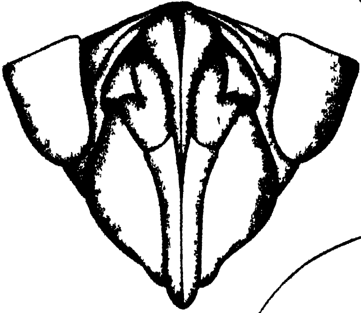
FIGS 1 to 9. Ventral view of female pygofer, drawn from specimen relaxed in boiling water.

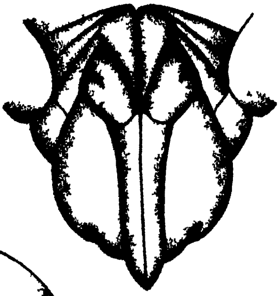
PLATE XIX.

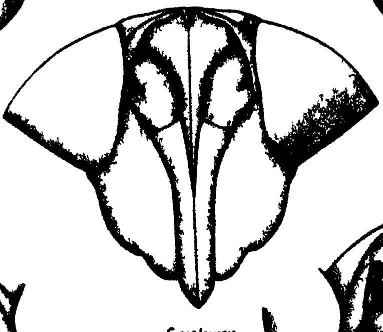

1 C juniperina

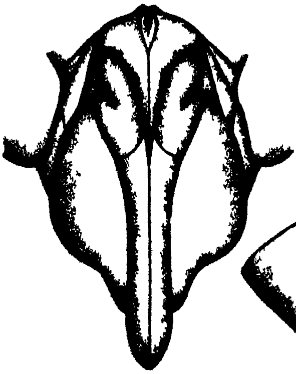

2 C media

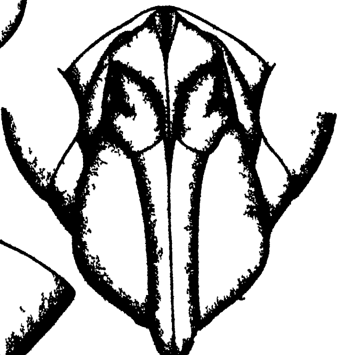

3 C arborina


4 C ovata


5 C newporta


6 C siskiyou


7 C elongata


8 C tricincta

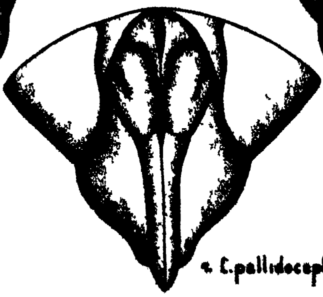

9 C pallidocephala

PLATE XX.

Fig. 1. Lateral valve of ovipositor.
Fig. 1*a*. Inner valve of ovipositor.
Fig. 2. Lateral valve.
Fig. 2*a*. Inner valve.
Fig. 3. Inner valve.
Fig. 3*a*. Lateral valve.
Fig. 4. Inner valve.
Fig. 4*a*. Lateral valve.
Fig. 5. Inner valve.
Fig. 5*a*. Lateral valve.
Fig. 6. Inner valve.
Fig. 6*a*. Lateral valve.

PLATE XX.

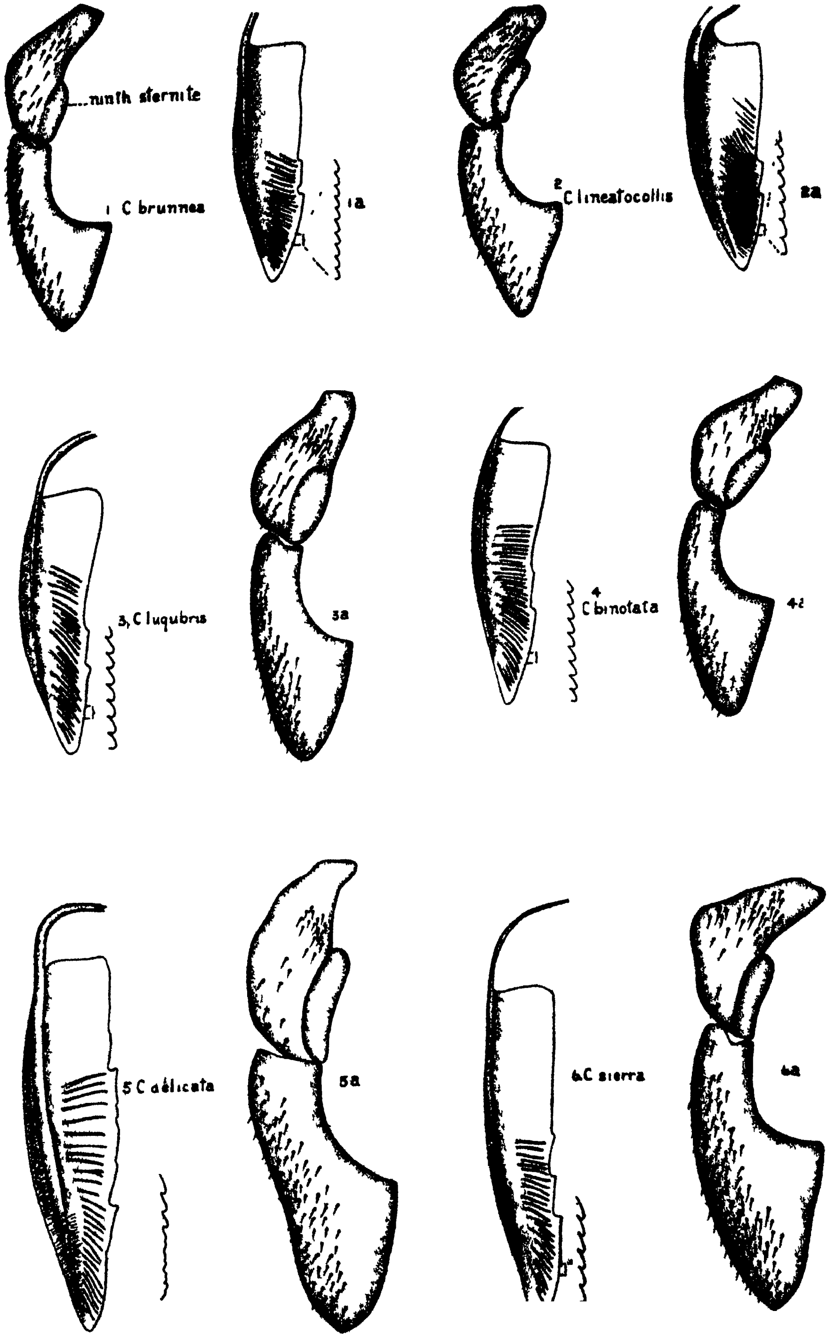

ninth sternite
1 C brunnea
1a
2 C lineatocollis
2a
3, C lugubris
3a
4 C binotata
4a
5 C delicata
5a
6 C sierra
6a

PLATE XXI

FIG 1	Lateral valve of ovipositor	FIG 4a	Inner valve
FIG 1a	Inner valve of ovipositor	FIG 5	Inner valve
FIG 2	Inner valve	FIG 5a	Lateral valve
FIG 2a	Lateral valve	FIG 6	Lateral valve
FIG 3	Lateral valve	FIG 6a	Inner valve
FIG 3a	Inner valve	FIG 7	Lateral valve
FIG 4	Lateral valve	FIG 7a	Inner valve

PLATE XXI.

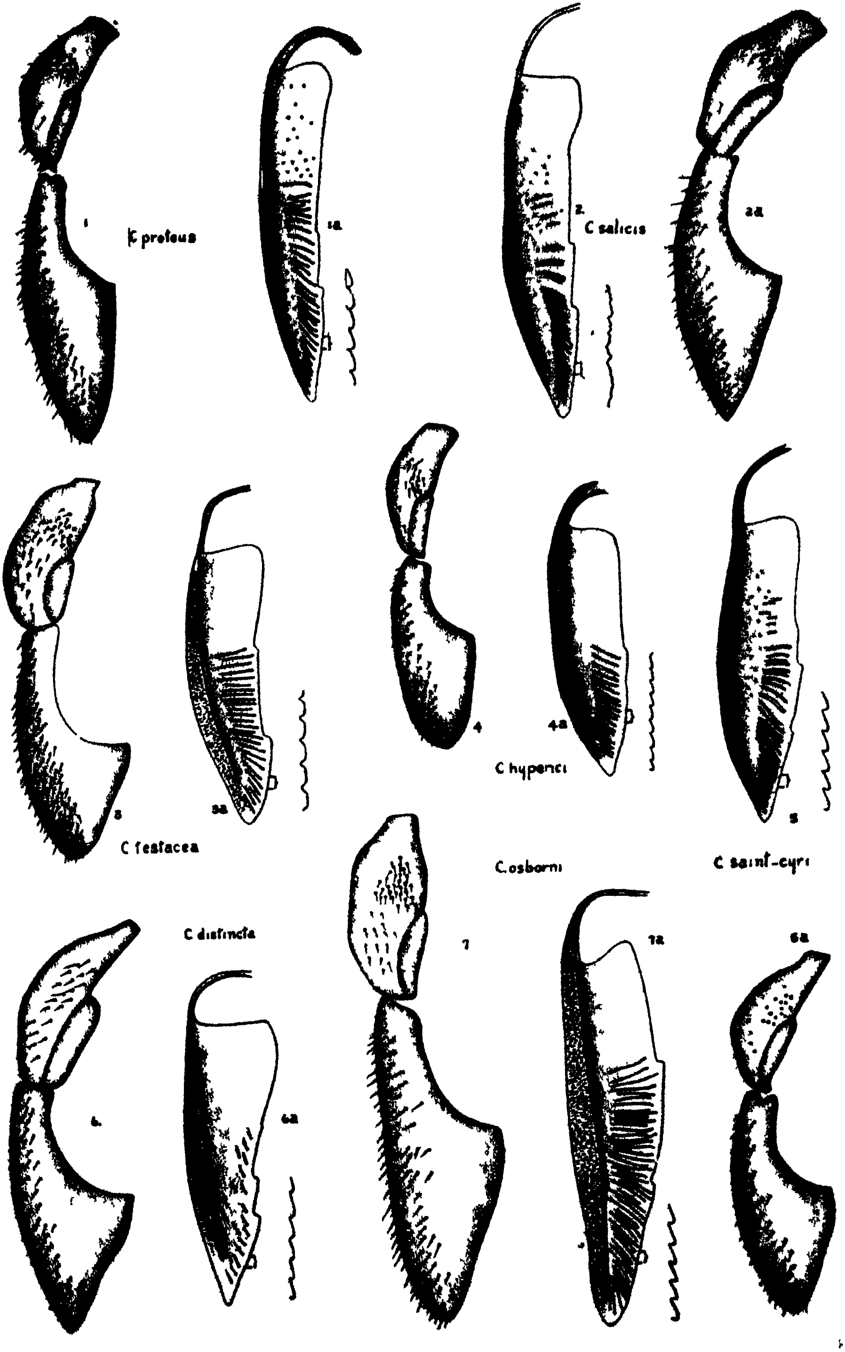

1
C proteus
1a
2
C salicis
2a
3
3a
C testacea
4
4a
C hyperici
5
C osborni
C saint-cyri
C distincta
7
7a
6a
6
6a

PLATE XXII.

FIGS. 1, 2, 3. Lateral valve of ovipositor.
FIGS. 1*a*, 2*a*, 3*a*. Inner valve of ovipositor.
FIG. 4. Lateral valve.
FIG. 4*a*. Inner valve.
FIG. 5. Lateral valve.
FIG. 5*a*. Inner valve.
FIG. 6. Inner valve.
FIG. 6*a*. Lateral valve.
FIG. 7. Inner valve.
FIG. 7*a*. Lateral valve.
FIG. 8. Inner valve.
FIG. 8*a*. Lateral valve.

PLATE XXII

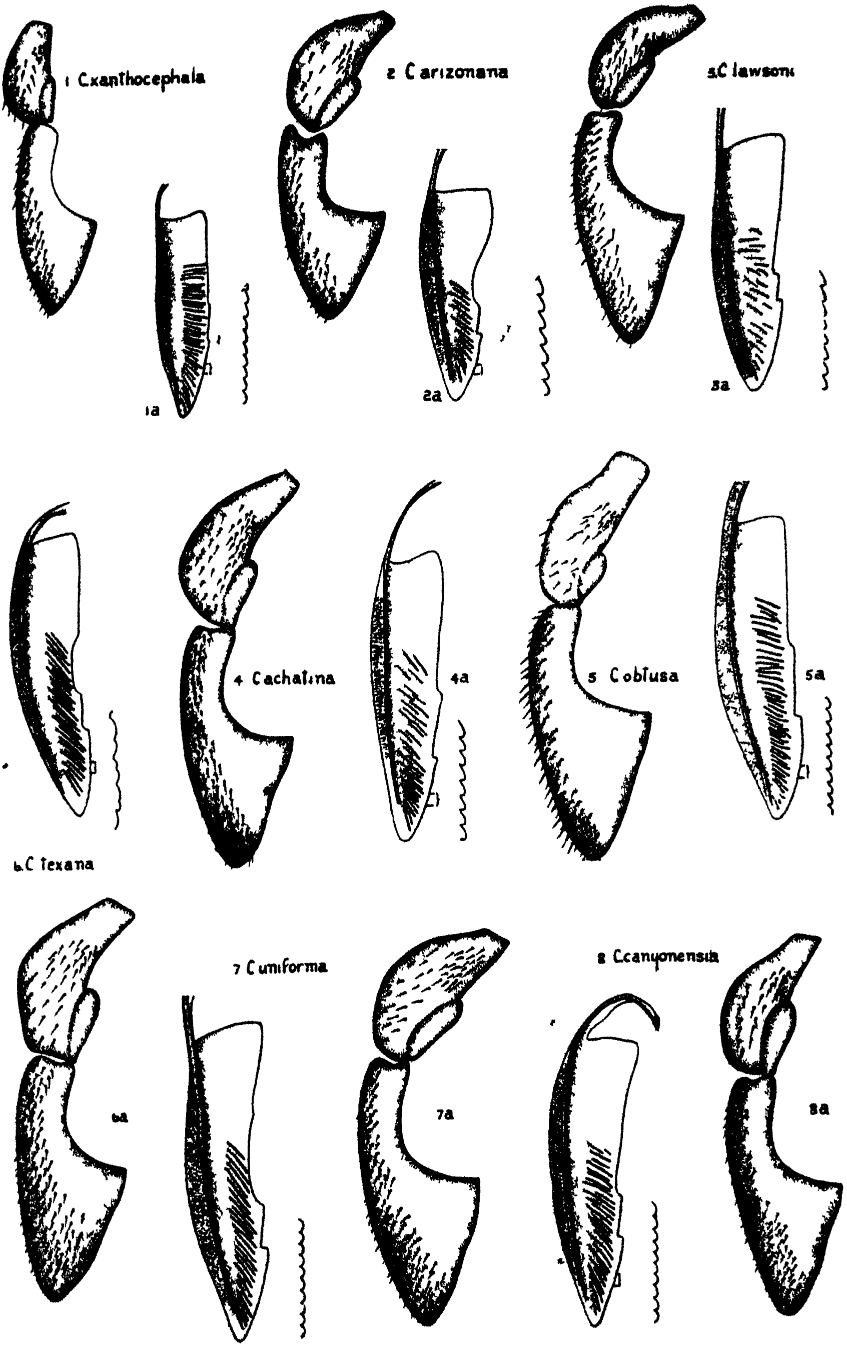

1 C xanthocephala
1a
2 C arizonana
2a
3 C lawsoni
3a
4 C achatina
4a
5 C obtusa
5a
6 C texana
6a
7 C uniforma
7a
8 C canyonensis
8a

PLATE XXIII.

FIG. 1. Lateral valve of ovipositor.
FIG. 1*a*. Inner valve of ovipositor.
FIG. 2. Lateral valve.
FIG. 2*a*. Inner valve.
FIG. 3. Lateral valve.
FIG. 3*a*. Inner valve.
FIG. 4. Inner valve.
FIG. 4*a*. Lateral valve.
FIG. 5. Lateral valve.
FIG. 5*a*. Inner valve.
FIG. 6. Inner valve.
FIG. 6*a*. Lateral valve.
FIG. 7. Lateral valve.
FIG. 7*a*. Inner valve.
FIG. 8. Lateral valve.
FIG. 8*a*. Inner valve.
FIG. 9. Inner valve.
FIG. 9*a*. Lateral valve.

PLATE XXIII.

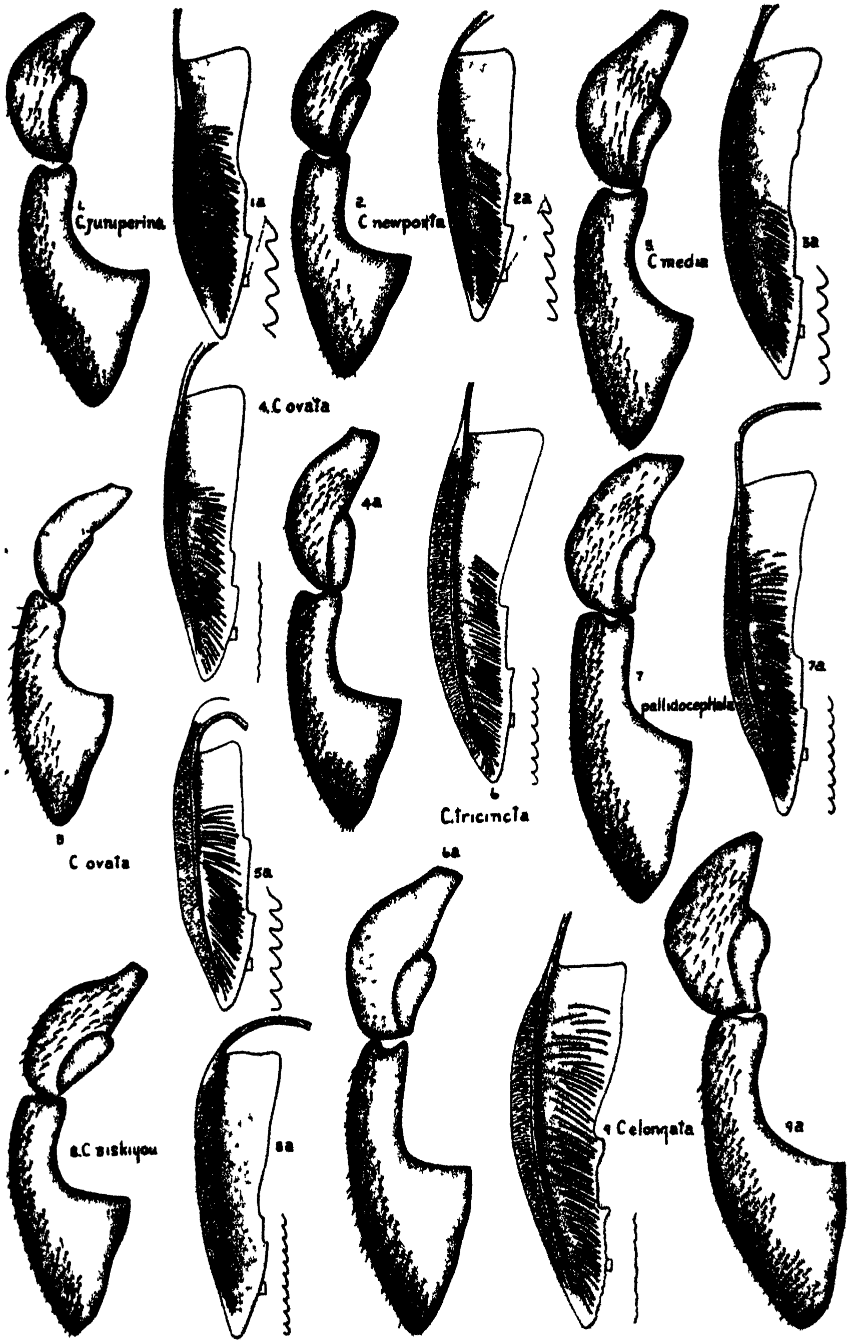
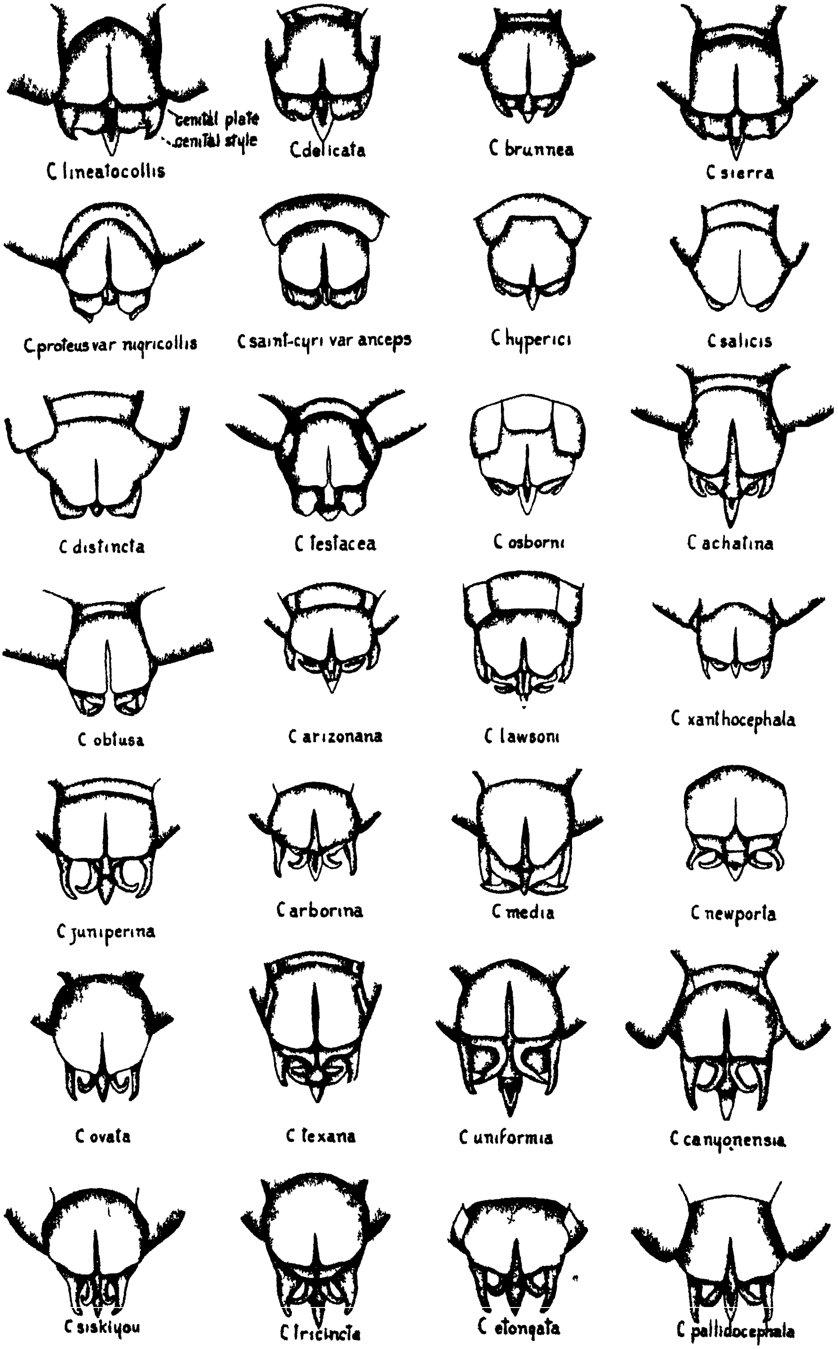

1. C.juniperina
1a
2. C newporta
2a
3. C media
3a
4.C ovata
4a
5
C ovata
5a
6
C.tricincta
6a
7
pallidocephala
7a
8.C siskiyou
8a
9 C elongata
9a

PLATE XXIV.

Ventral view of male pygofer, drawn from specimens relaxed in boiling water, after which the abdomens or pygofers were removed from body in order to draw.

PLATE XXIV.



C lineatocollis
C delicata
C brunnea
C sierra
C proteus var nigricollis
C saint-cyri var anceps
C hyperici
C salicis
C distincta
C testacea
C osborni
C achatina
C obtusa
C arizonana
C lawsoni
C xanthocephala
C juniperina
C arborina
C media
C newporta
C ovata
C texana
C uniformia
C canyonensis
C siskiyou
C tricincta
C elongata
C pallidocephala

PLATE XXV.

FIG. 1. Dorsal view of male genitalia.
FIG. 1*a*. Lateral view of style.
FIG. 1*b*. Ventral view of style.
FIG. 2. Ventral view of style.
FIG. 2*a*. Dorsal view of male genitalia.
FIG. 3. Dorsal view of male genitalia.
FIG. 3*a*. Lateral view of style.
FIG. 3*b*. Ventral view of style.
FIG. 4. Dorsal view of genitalia.
FIG. 4*a*. Lateral view of style.
FIG. 4*b*. Ventral view of style.
FIG. 5. Lateral view of style.
FIG. 5*a*. Ventral view of style.
FIG. 5*b*. Dorsal view of genitalia.
FIG. 6. Lateral view of style.
FIG. 6*a*. Ventral view of style.
FIG. 6*b*. Dorsal view of genitalia.
FIG 7. Dorsal view of genitalia.
FIG. 7*a* Ventral view of style.
FIG 7*b*. Lateral view of style.
FIG 8. Dorsal view of genitalia.
FIG 8*a*. Lateral view of style.
FIG 8*b*. Ventral view of style.
FIG. 9. Dorsal view of genitalia.
FIG. 9*a*. Ventral view of style.
FIG. 9*b*. Lateral view of style.
FIG. 10. Dorsal view of genitalia.
FIG. 10*a*. Ventral view of style.
FIG. 11. Dorsal view of genitalia.
FIG 11*a*. Ventral view of style.
FIG 11*b*. Lateral view of style.

PLATE XXV.

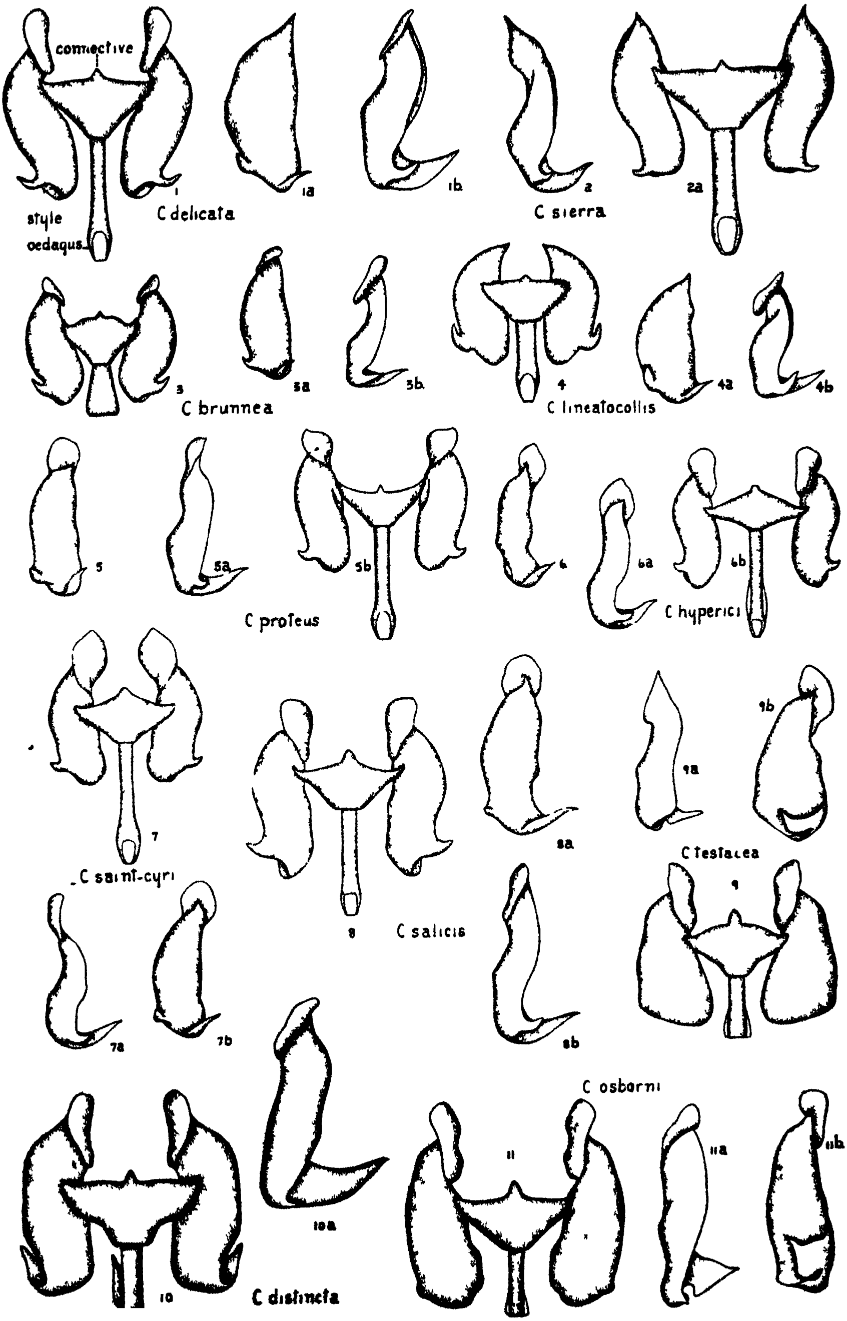

connective
style
oedagus
1
C delicata
1a
1b
2
C sierra
2a
3
C brunnea
3a
3b
4
C lineatocollis
4a
4b
5
5a
5b
C proteus
6
6a
6b
C hyperici
7
C saint-cyri
8
C salicis
8a
9a
9b
C testacea
9
7a
7b
8b
C osborni
10a
11
11a
11b
10
C distincta

PLATE XXVI.

Fig. 1. Dorsal view of male genitalia.
Fig. 1*a*. Ventral view of style.
Fig. 1*b*. Lateral view of style.
Fig. 2. Ventral view of style.
Fig. 2*a*. Lateral view of style.
Fig. 2*b*. Dorsal view of genitalia.
Fig. 3. Ventral view of style.
Fig. 3*a*. Lateral view of style.
Fig. 3*b*. Dorsal view of genitalia.
Fig. 4. Dorsal view of genitalia.
Fig. 4*a*. Ventral view of style.
Fig. 4*b*. Lateral view of style.
Fig. 5. Ventral view of style.
Fig 5*a*. Lateral view of style.
Fig. 5*b*. Dorsal view of genitalia.
Fig. 6. Ventral view of style.
Fig. 6*a*. Dorsal view of genitalia.
Fig 7. Dorsal view of genitalia.
Fig. 7*a*. Ventral view of style.
Fig. 7*b*. Lateral view of style.
Fig. 8. Ventral view of style.
Fig. 8*a*. Dorsal view of genitalia.

PLATE XXVI.

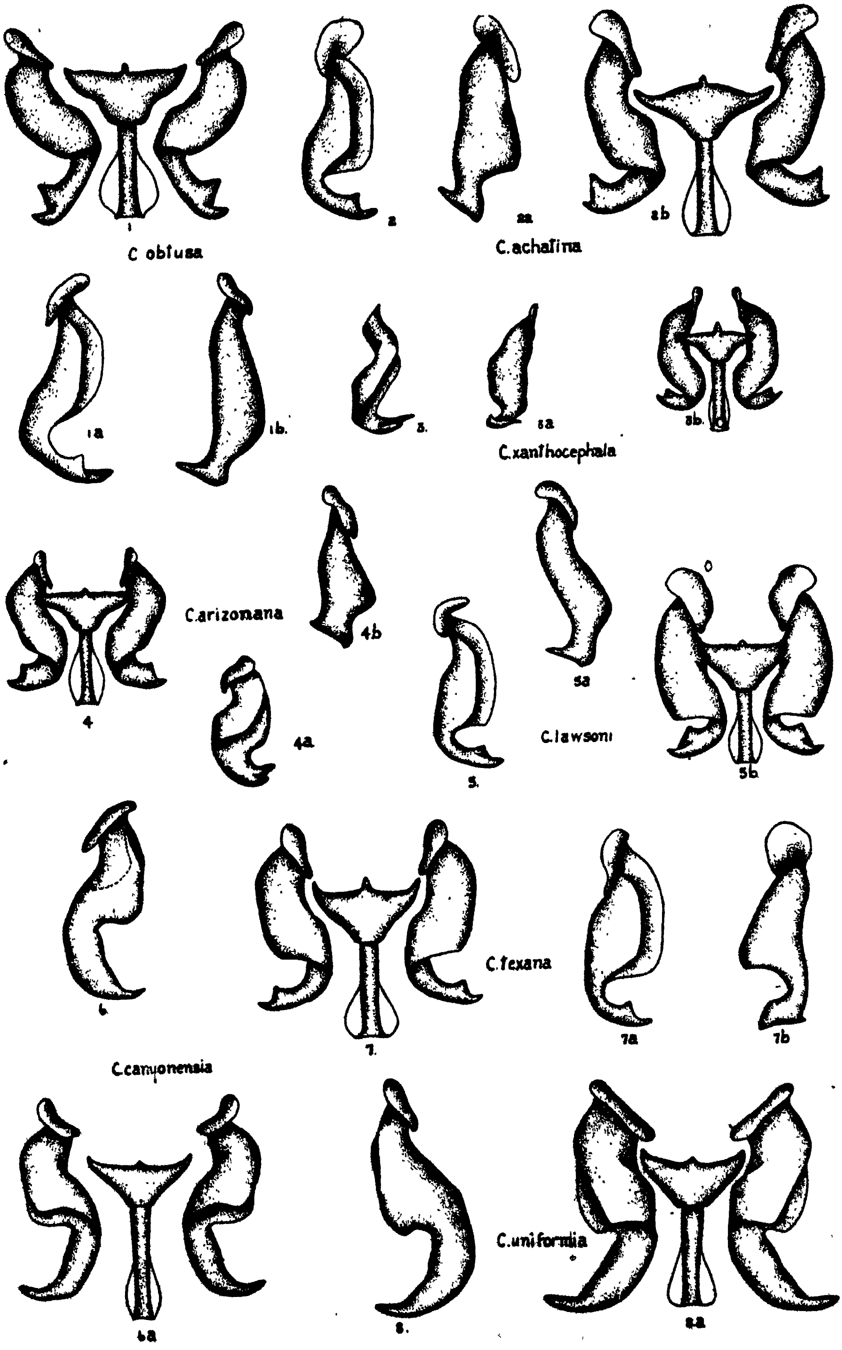
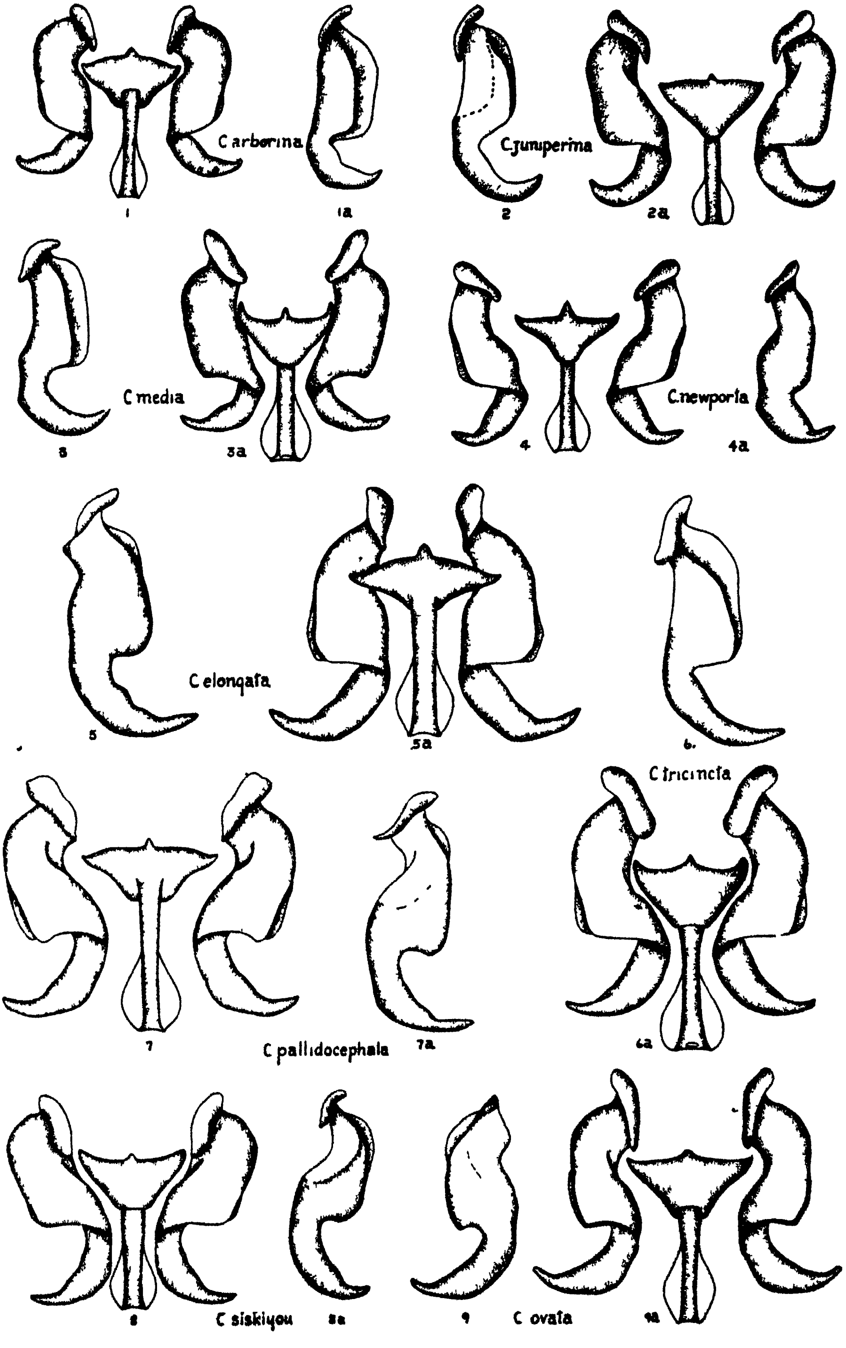

1
C obtusa
2
2a
2b
C.achalina
1a
1b.
3.
3a
3b.
C.xanthocephala
4
C.arizonana
4b
4a
5a
C.lawsoni
5.
5b
6
7
C.texana
7a
7b
C.canyonensis
6a
8.
C.uniformis
8a

PLATE XXVII.

Fig. 1. Dorsal view of male genitalia.
Fig. 1*a*. Ventral view of style.
Fig. 2. Ventral view of style.
Fig. 2*a*. Dorsal view of genitalia.
Fig. 3. Ventral view of style.
Fig. 3*a*. Dorsal view of genitalia.
Fig. 4. Dorsal view of genitalia.
Fig. 4*a*. Ventral view of style.
Fig. 5. Ventral view of style.
Fig. 5*a*. Dorsal view of genitalia.
Fig. 6. Ventral view of style.
Fig. 6*a*. Dorsal view of genitalia.
Fig. 7. Dorsal view of genitalia.
Fig. 7*a*. Ventral view of style.
Fig. 8. Dorsal view of genitalia.
Fig. 8*a*. Ventral view of style.
Fig. 9. Ventral view of style.
Fig. 9*a*. Dorsal view of genitalia.

PLATE XXVII.


C arborina
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1a
C.juniperina
2
2a
C media
3
3a
4
C.newporta
4a
C elongata
5
5a
6
C tricincta
7
C pallidocephala
7a
6a
8
C siskiyou
8a
9
C ovata
9a

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Studies on the Biology of Kansas Cicadidæ.*

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INTRODUCTION.

MY interest in cicadas was first aroused by the sport involved in collecting them. Almost anyone enjoys hunting quails with a good gun and a good dog. How much more interesting it is to hunt cicadas; detect them by their song from the myriad other noises of a summer day; locate the singer by his repeated cries; and then, either take him with a net or shoot him with a rifle in true sportsman style. The cunning of the hunter also is necessary in taking cicadas. A hurried movement or a broken twig, and the song stops as though broken in the middle, or with a wild squawk and a buzz of wings the game is off to safer quarters.

Interest in the biology of these insects grew quite naturally from collecting them. Occasionally females were found ovipositing. From nests of eggs collected it was noted that the eggs of some species did not hatch till the following year, and fortunately, unlike the seventeen-year cicada, the eggs remained in good condition though the limbs bearing them were cut from the trees. From material thus kept in the laboratory, two new species of nest parasites were found. Thus at every turn new and interesting facts in their biology were brought to light.

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* Submitted to the Department of Entomology and the faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

The following pages are an attempt to set down the interesting things noted about some of our common Kansas cicadas. Fifteen species have been studied representing five of the seven genera occurring in the state.

ACKNOWLEDGMENTS.

Acknowledgment is here given to Dr. H. B. Hungerford for his generosity in furnishing funds and in granting time for these studies, and for his stimulating suggestions and criticisms of methods to be used; and to Dr. Paul B. Lawson, under whose immediate direction the problem was undertaken, for his generous coöperation in the field and laboratory, for his detailed criticism of each step of the work, and for his suggestions of many of the worthwhile phases investigated. This opportunity is taken to thank Mr. Wm. T. Davis, of Staten Island, N. Y., for his kindly interest and constant inspiration in this attempt to learn something of the biology of the cicadas; and also Messrs. A. B. Gahan, S. A. Rohwer and J. M. Aldrich, of the United States National Museum, for the identification of parasites. Mr. R. E. Snodgrass also has been most generous in furnishing unpublished drawings and manuscript notes on the morphology of the cicada. Many others have assisted in collecting material and gathering data. Among these Mr. H. Steele, of Scott City, Kan., and Mr. John Wilson, of Elk City, Kan., deserve special mention. Throughout the course of these investigations Mrs. Lucy Dunbar Beamer, my wife, has been of incalculable assistance by sharing with me the burden of caring for the insects under observation and by her help in the preparation of the plates.

NATURE OF THE PROBLEM.

Since the seventeen-year cicada, *Magicicada septendecim* (Linn.), the only one whose life history is known, spends such a long period of time underground, it is natural that particular attention should be given to the developmental stage of these insects. Questions present themselves as to the number of instars; morphological characteristics of each stage; the duration of each stadium; the food preferences of the nymphs of each species, if any; and the mysteries of their movements underground. Along with so many things of interest occurring beneath the soil, the emerging nymph introduces us to many new problems in the open air.

The oft repeated statement that the adult cicada takes no food makes the question of feeding very interesting. Mating and oviposition are other absorbing problems. Where do they lay their eggs? In what type of substance—green or dead tissue—trees or grasses? What kind of nests do they make? Do they fill them with secretions of any kind? Does the dying of the twig kill the eggs? What egg parasites are to be found? A multitude of questions arise in this part of the life cycle. The hatching of the eggs, effect of heat and moisture upon hatching, the making of underground cells by the nymph, all present phenomena of intense interest.

The above queries introduce some unique difficulties. First of all, the only species about which anything is known takes seventeen years to go through its life cycle—an astounding length of time when one considers the attempt to work out the life history in detail. The unity of opinion among writers, however, that perhaps most or even all other species pass through their life cycle within a year, or two years at most, gave some encouragement in attacking the problem.

Another difficulty presented itself by the occurrence of different species emerging in localities many miles apart. For example, the past year (1926), three species were studied in Scott county, Kansas, and three others in Cherokee county, Kansas. The two localities are 400 miles apart by automobile. Then, too, some of these species are tree-loving forms, and he who would learn of them must simulate the habits of a squirrel. The shyness, also, which most members of this family exhibit to the would-be observer is no small obstacle in obtaining worth-while data.

Attempts to collect nymphs in the field for study and rearing purposes have been made. These have proved feasible only under the most favorable conditions. Comparatively speaking, very few individuals of a species emerge each year in a given area. This fact is indicative of the number of nymphs in the ground at a given place and time. For example, let us suppose that in a ten-acre wood lot with a tree on every ten-foot square there is a pair of cicadas in each tree. No one would gainsay that the lot would be a perfect din with their songs, but if one were to fry to find the nymphs of one of these pairs in the ground beneath their tree, tons of earth would have to be moved and examined. This has been, indeed, a very real difficulty.

To add to the problem the nymphs of different species within the genus are so nearly alike that only where one species occurs alone in a locality can one be reasonably sure of the identity of his material, even if he finds it.

The problem is rendered still longer and more difficult by the fact that the adults occur but once a year, and then, in the case of most species, for only a few weeks. In addition, a large brood of a given species may occur in a certain locality only once in a number of years. Nevertheless the problem has become increasingly interesting, and plans have been made to continue the studies until many of the still unsolved mysteries have been answered.

HISTORICAL SKETCH.

Long before the science of biology was born, before the habit of attempting to explain the phenomena of life had been developed, even before written records were kept of the thoughts of peoples, the cicada had attracted attention. The Egyptians gave images of this insect a religious significance. The ancient Greeks used them as a symbol of music and also as a decoration on coins The Athenians fashioned golden ornaments in their likeness. In early writings they were often praised because of their song, and even held as almost sacred. For centuries the Chinese have used them for their coloring matter and medicinal properties. A common superstition has been handed down that the "W" in the cicada's wing forecasts war.

Records of many primitive peoples of the past and of the present show cicadas have been used as articles of food. Aristotle wrote that they were most edible just before emergence. Reaumur tells us that some of the ancients ate the males before mating and the females after. He adds that they liked the eggs of cicadas as the French people of his day enjoyed crab eggs.

The first record of the seventeen-year cicada (the most famous member of the family) was made by Oldenberg, London, in 1660, in a paper entitled "Some Observations of Swarms of Strange Insects and the Mischief Done by Them." Unfortunately, in this paper he used the term locusts, thus confusing them from the first with the true locusts (Locustidæ). The brood which he had observed occurred in 1634 in New England. The colonists reported at this time that the American Indians used the cicadas as food; and Andreas Sandel, of Philadelphia, in 1715 again mentioned this custom. The first serious attempt at a study of the biology and morphology of cicadas, however, was made by Reaumur in 1740. So accurate was his description of the sound-producing organs of the male that it is still used. He also made observations of the nests and the eggs. He observed nest parasites, but made no attempt to preserve them or place them systematically other than to say they were ichneumonids. He tried to hatch the cicada eggs, but had very poor results, failing to observe the process.

A century later Fabre, in his pleasing way, recorded many interesting observations on the oviposition, the nests, the eggs and the hatching of the cicada. He observed hymenopterous parasites laying eggs in the cicada nests but, like Reaumur, failed to record the identity of them. He even made an attempt to rear the nymphs in a bowl of growing wheat and heather. This, however, failed and he decided that, while it might be done, it was not worth the effort.

Little has been done on the biology of cicadas other than *Magicicada septendecim* (Linn.) since the time of Fabre A detailed account of the work done on this species has been given by Marlatt, United States Department of Agriculture Bureau of Entomology Bulletin No. 71, 1907, and it will not be repeated here. Even with this species, where thousands of eggs were available, rearings in captivity failed. The data obtained were gained from digging under trees where nymphs were known to have hatched in great numbers. Numerous writers have recorded notes on the oviposition, nests, eggs, etc., of some local species. Several have studied in greater or lesser detail the song and song habits of various forms. Snodgrass and Muir have done valuable morphological work on the group. It is hoped the following notes will be of interest and will add to what is already known of the biology of the cicadas.

TECHNIQUE OF DETERMINING THE LIFE HISTORY.

A STUDY OF BROODS.

Former writers have suggested that the life histories of cicadas might be indicated fairly accurately from the occurrence of extra large broods in the field. For the past four years records have been kept on broods of different species in several localities. Whenever a large brood of any species has been observed, the locality and species have been noted, and also the time of year of the occurrence of the largest numbers of individuals. Then other notes have been taken of the habits of the particular species, such as the time of day the males usually sing, the type of hosts the females use for oviposition, and the general appearance of the plants bearing nests. The localities have been visited each succeeding year as nearly as possible at the time most favorable for finding the maximum number of individuals. The comparative numbers of some of the small, grass-loving species are estimated by collecting them by sweeping; the large, wary species are usually judged by the song of the males. Something of the size of the brood may be ascertained by the number of cast nymphal skins on the ground or vegetation and by the oviposition marks left by the females where these are of a nature to be seen easily. Both details are accurate indicators, since one readily learns to distinguish between new and old. Cast nymphal skins will remain recognizable for a year, but they show the effect of weather and would not be mistaken for newly cast ones. The nests may be more confusing, but a little study soon renders one quite expert in judging their age, and there is always the test of cutting into the nest to find it either empty or containing live eggs.

Size of broods can be expressed only in relative terms, as large or small, and the judgment of the observer would be valuable in proportion to his experience. So far no method of measure has been devised.

Observations indicate that a great many records of a species should be obtained, and perhaps records in more than one locality, before an accurate conjecture could be made as to the length of its life history. This is due not only to the fact that there might be more than one large brood in a locality, but also to the many factors which might cause a large brood to be diminished to a small one.

DATA ON LIFE HISTORY BY DIGGING NYMPHS IN THE FIELD.

Hope was entertained that a shorter and more accurate method might be found for obtaining data on the life history of cicadas by digging for nymphs in the field. Accordingly many hours have been spent in this way with gratifying success in a few instances and disappointment in many.

WHERE TO DIG. Locations were selected where a species had been known to be abundant. Often old oviposition marks determined the exact place for excavating. In timber, the north side of large trees near the trunk yielded the best results. Some locations, which might have proved fruitful, were impractical because of the rocky nature of the soil. Digging has been delayed occasionally by prolonged drouth. Not only is the labor of digging in dry soil greater, but a much higher percentage of individuals is injured in the operation. In all cases more large nymphs were found than those of the smaller instars. This is probably due to the fact that as the nymphs increase in size their cells are more often broken open, and also to the fact that a large nymph is less apt to be overlooked. In a locality where dozens of fifth-instar nymphs were taken only two second-instar individuals were found; yet the next year many third instars were collected, indicating that they had been present the year before.

EQUIPMENT NECESSARY. A tile spade, a large bladed knife, and a pair of tweezers constitute the equipment most often used in digging for nymphs. Wide-mouthed bottles containing 70 per cent alcohol are used for preserving the material in the field. If nymphs are to be taken to the laboratory alive, suitable containers must be provided. This will be discussed in detail a little later.

METHOD OF FINDING THE NYMPHS. Large spades of dirt are cut loose and carefully lifted to a nearby natural clearing or to an artificial one made by unfolding a heavy newspaper. The sides of the excavation and of the removed lump of dirt are then examined carefully for nymphs which may have been expelled from their cells or for burrows into which the excavating has broken. When these leads have been examined and any material removed, the sod is held about a foot above the improvised worktable and gently torn to pieces. Work may be accelerated and also made more accurate by a helper carefully watching the surface of this table as the particles fall. In most soils the nymphs are readily seen because of the difference in color. As each additional spade of soil is removed, it is examined over the same place, thus soon building a small, flat-topped mound which forms a convenient worktable.

As the nymphs are discovered they may be removed to the alcohol vials by means of tweezers, but, if live specimens are to be obtained, this method of handling has proved undesirable because so many specimens are injured. Often nymphs will grasp the tweezers with their front legs and may be lifted thus to the live cage. Otherwise they should be rolled gently into the hand or lifted with the knife blade and again gently rolled from the hand or knife into the awaiting container.

In the case of the seventeen-year cicada, and occasionally with large broods of other species, a satisfactory method is that of removing the soil above a root for a few feet, then cutting the root loose at one end and gently raising it. The largest number of nymphs will have formed cells perpendicular to and directly beneath such roots. Removing the root leaves the cells open at the top, hence easily seen.

TRANSPORTING LIVE NYMPHS. Specimens left exposed to the dry air for any considerable time are destroyed by desiccation. If numbers are confined in the same container without partitions, they mangle each other with their sharp claws. The first attempt to overcome these difficulties was to cover each specimen as found with loose earth. This relieved the above-mentioned conditions, but the nymphs were often injured by the weight of the dirt. A nymph will dig in the most compact soil, provided it is not too dry, but it finds itself at a great disadvantage in loose earth. If it cannot make the soil hold together and fashion an open space or cell, it can only flounder helplessly, bruising its soft body with the hard particles and gradually wearing away its strength.

IN MUD CELLS. Individual cells made from mud proved a safe way to transport them. A nymph so placed will ride in a car for hours uninjured provided only that the ball remains whole. A more desirable method where many nymphs were to be transported was that of placing a layer of stiff mud about one inch deep in a flat box and putting the individuals in artificial cells. As each cell was filled, it was capped with a bit of flattened mud to prevent the escape and desiccation of the occupant. Nymphs have been thus inclosed without injury for a longer period during cold weather than hot. If the container was too tightly closed, nymphs confined for many hours have been found to be suffocated. Specimens which appeared dead from suffocation have been revived by leaving them in the open air for a short time. Where they were left for hours, a wet cloth was spread over the container. Numerous nymphs, thus revived, have formed cells and apparently recovered completely.

IN LIVE CAGES. Live cages have been taken into the field and the nymphs placed in them as they were found. This has proven a most desirable way where it is possible. Live cages have the advantage over the mud cell in that the new home formed is permanent. Newly transplanted nymphs begin work on the new cell immediately if kept in a warm place.

EXAMINATION OF MATERIAL IN THE LABORATORY. Hundreds of preserved nymphs were studied in the laboratory in an attempt to determine the number of instars and the length of the life history. The nymphs of a species were first separated as to apparent size. Then each size was studied in detail under the microscope. The hard parts were measured. The number of segments of the antennæ was compared in specimens of the same size and those of other sizes. The number of setæ-bearing spines on the hind legs was compared. The development of the front femora and tarsi was studied, as to size, number of teeth in the comb, etc. The size of the wing pads, size and shape of the pronotum, the genitalia, and general and specific color changes were all noted. From all these studies it seemed impossible to decide the number of instars. Size divided them into several groups. Even measurements of the hard parts, which supposedly do not change within an instar, were found to vary. The character of the antennæ seemed to divide them into five groups, but the variation in size of other parts was so great that it was impossible to tell whether the differences were due to added age or inherent nature of the individual. So many empty shells of nymphs having large wingpads had been found in burrows in the field that it was considered these large nymphs perhaps molted once during this stage.

Accurate data now seemed to depend upon actual rearings in captivity. Since the small size of year-old nymphs hatched and reared thus far in the insectary indicated a relatively long life history for all cicadas, an attempt was made to trick nature into giving up her secret in a shorter time by simultaneous rearing of the various instars which were found in the field.

FLOWER-POT CAGES. A large number of experiments have been conducted in an attempt to determine the best types of live cages to use. Eggs have been hatched over large flower pots of perennial grass, and a year later the nymphs found by carefully tearing the dirt into fine particles. This cage has proved valuable when only growth of the nymph was desired, but it was obviously not practical for catching molts or for observing habits. To meet this need, small glass-sided cages were constructed.

SMALL GLASS-SIDED CAGES. Three sides of a wooden frame one-half to one inch deep by four inches wide by five inches long were nailed together and a 4 x 5 glass plate placed on either side of it. The sides were fastened in place by two wraps of a very fine copper wire. Small lead lugs were numbered and tied on these wires for records.

HOST PLANTS. Since the first nymphs found in the field had been living on *Panicum virgatum,* small green sprays of this grass were dug and placed in a dozen or more of these cages with good, rich soil. The results were disappointing. This grass, divided down as small as was necessary, would not take root and grow as it should. One of two things seemed necessary. Either larger cages must be used to allow the large grass to grow, or smaller grasses or other small plants must be found on which the nymphs could live.

An attempt was first made to give the large grass room to grow, and at the same time isolate some of its roots in small amounts of soil surrounded by glass so that observations could be made without disturbing the plant or insects. Six holes were bored in the bottom of a box and small test tubes, punctured at the closed end to allow the escape of excess moisture, were inserted in these holes. Then grasses were placed in the box with a healthy root extending the length of the test tube and the tubes filled with finely sifted and sterilized earth. The nymphs were placed in the test tube, and when they had disappeared into the soil, the box was filled with more of the sterilized dirt. The soil was then moistened and the box buried in loose sand in the laboratory. Another attempt to accomplish the same result was made with glass cylinders. A smaller cylinder closed at one end was inverted in a larger cylinder. Grasses were placed in the large beaker with their roots extending around the inner cylinder. When the cage was partly filled with soil the nymphs were placed between the two glass walls. Then the space above was filled with soil. In both types of cages the nymphs and the grasses lived, but neither plan was considered a success because the thinnest film of dirt over the glass obstructed observation and to remove the film it was necessary to demolish the cage.

ANNUALS AS HOST PLANTS. At the same time the above experiments were being run, small annual grasses were being tried in the glass-sided cages described above. They grew rapidly, and nymphs placed among their roots gave every evidence of being in perfect condition. This encouraged the belief that cicada nymphs are not specific feeders, and experiments were started to determine what kind of plants would make the most ideal hosts for them. Former writers have held that nymphs probably passed the winter in a dormant state and hence could live where only annuals were available. All material, however, which was left in cages containing annuals died when the grasses ripened in the fall.

VEGETABLES AS HOSTS. A series of experiments was begun to determine, if possible, whether cicada nymphs might secure food from fresh tubers. Fifth instar *Magicicada septendecim* (Linn.) were used in the trials, with potatoes as the host.

Two methods were tried: First, a hole was made in the potato about the diameter of the cells from which the cicadas were taken. These holes were closed by small pieces of celluloid inserted through slits made in the potato. (Pl. XXXIII, Fig. 5.) Second, the cicadas were placed in artificial cells in a pan and the top of the holes capped with small potatoes.

These experiments were started on December 4, 1926, with fifteen nymphs. They were kept in the laboratory where the temperature was warm enough to allow normal activity.

RESULTS. Of the five nymphs placed inside the potatoes one died December 19, one December 20, two others were dead February 1, and the last, though still alive, was noticeably diminished in size March 10, 1927. These nymphs were observed with the beak imbedded in the potato, apparently feeding. All of them clawed loose many bits of potato and attempted to arrange them near the opening of their cells. A small lump of dirt placed in one hole was used to cement the space around the window. It did not seem to be the light from the opening that worried the cicada, but the air that got in about the edge of it, and when this was sufficiently closed no more attention was paid to this sort of occupation. While this experiment would discourage the hope of using potatoes as hosts for cicada nymphs for any considerable period of time, it did give evidence that the above technique might prove a convenient and highly successful method of transporting nymphs for long distances. It seems probable that by using a little care in making the hole in the potato approximately the size of the normal cell and carefully sealing it shut to prevent desiccation and escape, nymphs might be so shipped with minimum expenditures of preparation, postage and fatality.

The second method has proved more successful. At first the nymphs sealed the cells with soil, but, failing to find food elsewhere, they eventually came back to the potato. Often when the potato was raised for observation the beak of the cicada would be so firmly imbedded that the nymph was raised out of the cell. They tunneled about in the pan considerably, sometimes two nymphs opening holes very near each other. The nymphs in this type of container frequently opened their cells to the outside and left them open for days at a time. No explanation is offered as to why this was the case. An examination March 12, 1927, showed three nymphs in well developed cells in the bottom of the container living on the roots of the potatoes, which at this time had begun to grow. They seemed in fair condition, and might emerge in due time. It is possible that cicada nymphs can be carried through their entire cycle in this manner. However, success seems to be due not to the tuber but to the roots that form from it.

OTHER PLANTS. Experiments were conducted with a number of other plants. Wheat suggested itself as a winter food, but it proved to be too easily injured by changes of moisture and by disturbing the root mass in making examinations. Orchard grass, *Dactylis glomerata* L., and dandelion, *Taraxacum officinale* Weber, were next tried with excellent results. In about two weeks after transplanting they fill the cages with a wonderful system of tender roots, thus making it easy for the newly hatched or transplanted nymphs to find abundant food. In November, 1925, cages of this sort were carried in a car 400 miles to western Kansas and back again; nymphs were planted in them in the field, the grass lived, also the nymphs, some of them emerging this past summer (July, 1926). Blue grass, *Poa pratensis* L., *Sorghastrum nutans, Panicum virgatum,* orchard grass, dandelion and yucca were all used in large cages. Any of the above, with the exception of the first and last, appear to be satisfactory. Preference is shown, however, for the large-stemmed grasses because of the greater extent of the root masses. (Pl. XXXIII, Fig. 3.) Orchard grass forms many roots branching horizontally, which would increase the probability of newly hatched nymphs finding food, but the roots extend only a few inches deep. Dandelion grows deep but does not produce as dense a root mass, leaving the greater probability of tiny nymphs failing to find them. Yucca suggested itself because *Tibicen bifida* (Davis) eggs had been gathered in great numbers in Scott county, Kansas, placed in dead yucca stalks. It is a hardy plant, but the root system is too coarse and unbranched.

Because so many of our Kansas cicadas live in trees, experiments were started with trees as hosts. Willow, cottonwood, maple, and elm were potted. Trials with these have not proceeded far enough to draw definite conclusions as to their worth. A fifth instar of *Tibicen auletes* (Germar) taken from oak and placed in a cage of willow on June 25, 1926, emerged in August. Some *T. dealbata* (Davis), fifth-instar nymphs, placed in the same sort of cages in August, 1926, are still alive and doing nicely February 9, 1927. These meager results, however, would indicate that small trees may be successfully used in live cages. The trees are less hardy, however, and more apt to succumb to inadequate quarters than grasses.

LARGE GLASS-SIDED CAGES. During the second year it was found that some of the earthenware pots had been so badly broken by freezing and thawing that it was necessary to replace them. In trying to overcome this difficulty large glass-sided cages were made after the pattern of the smaller ones. Eight by ten glasses were used and placed on a framework of wood two to four inches deep. The glass was countersunk and held in place by wooden cleats. These cages proved most convenient and desirable in every way, except that the wood decayed (Pl. XXXIII, Fig. 1). Not only does the decaying render the cage difficult to handle and necessitate ultimate replacement, but large nymphs will burrow through it and escape. A fifth instar, *Magicicada septendecim* (Linn.), placed in a large cage of willow on June 1, 1926, had escaped in this manner before February 3, 1927, yet the cage was solid enough to hold together (Pl. XXXIII, Fig. 2). A more durable cage is now being constructed by using heavy galvanized iron for the sides.

TRANSPLANTING NYMPHS. Where nymphs are transplanted one side of the cage is removed and a hole large enough for the individual is made near the root. Transplanted nymphs, if placed near the top of the cage with only loose soil covering them, tend to work to the surface instead of going down. If they are being placed in pots which have been growing for some weeks, the soil may be removed intact by inverting the pot and artificial cells made for them among the roots several inches beneath the surface. As the nymphs are found at all depths from two to twelve inches in nature, they may be placed at varying depths in the cages. Care should be exercised to make these holes large enough to allow room for the nymph to use its legs and to turn over to place loosened dirt in another part of the chamber. About 40 nymphs, so placed among choice roots, were found dead when examination was made, because they had been placed in cells too small to allow them to work.

When nymphs were transplanted in the winter the cages were allowed to remain in a warm room until the nymphs had time to perfect their cells. This is essential, because they will not dig at low temperatures, yet they need the well-formed cell to protect them from drying and flooding, from injury from jar and attack from enemies. It is also considered that they feed in winter, so they should have their cells built around the food roots.

CARE OF CAGES. Cages containing nymphs are kept buried to the top in the open when not needed for observations. If exposed to air for long periods it is more difficult to keep the moisture content right for the host to thrive.

Observations should be made frequently enough to catch any changes which occur. During molting and emerging seasons daily examinations are desirable; or, if one hopes to observe the actual act of molting or transformation to adult, material must be kept under almost constant observation. If the glass becomes soiled, it may be removed, cleansed, and replaced. Often the glass will form a portion of the cell and activity may be observed with the cage intact. Cages containing nymphs which are nearly ready to emerge are kept under large frames covered with screen wire or mosquito netting. No protection is needed from rain or freezing after the nymphs have had time to form their cells.

REARING FROM EGG TO ADULT.

CARE OF EGGS. Unlike the nymphs, the eggs require very little care. So far but one species has been studied whose eggs dry up when the host plant withers. Although good eggs have been found in twigs which have been dry for long periods and also in stems badly molded from excessive moisture, natural conditions are maintained as nearly as possible by suspending the twigs bearing nests in trees out of doors soon after collection. Even eggs placed in dry tissue will shrivel if kept for a long time in very dry atmosphere.

HATCHING OUT OF DOORS. At first eggs were simply placed over pots containing the host plant and left to hatch naturally. It was thought the mortality was needlessly high with this method, due to a number of things. A hard storm, high wind, soil too wet or dry, might be disastrous to great numbers. Ants have been found on the stems containing the nests, devouring the nymphs as they emerged. The predacious enemies in the soil were also numerous. The defenseless nymphs must run the gamut of all these dangers.

HATCHING INDOORS. To reduce the mortality, the nests were taken into the laboratory as soon as red eyespots appeared. Flat-bottomed trays with a smooth surface were found most convenient as containers. The stems were moistened daily, and when hatching began were kept covered. Nymphs left in dry air become desiccated in a few minutes, but, if kept in a moist chamber, will remain in good condition for several hours. Moisture was supplied either by a damp cloth covering or a moistened sponge placed inside the tray. Excessive moisture is undesirable because the nymphs are helpless if caught in the surface tension of a drop of water. It became the custom to dip the nests in water and place the tray in the morning sunlight. Within an hour the eggs would begin hatching, and by the end of two hours the largest part of that day's hatch would be out. Newly hatched nymphs will not injure each other when placed together as do the older instars. Dozens of nymphs may be allowed to crawl about together without injury. At frequent intervals during the hatch the nymphs were removed, counted, and placed in cages.

CAGES FOR FIRST-INSTAR NYMPHS. When the nymphs were being plated for the purpose of obtaining data on the digging and feeding habits and on the time of the first molt, the small glass-sided cages were used. On the other hand, when the completed life cycle was desired, large flower pots or large glass-sided cages were used. In either case it is most essential to use cages that are well filled with healthy root masses. The soil should be thoroughly moist, yet not wet. If the soil is too dry the nymphs cannot form their cells. If it is too wet they will leave, if possible, and many of those that remain will become glued to their surroundings in some helpless position.

A few newly hatched nymphs were placed in a plate cage containing moist cellucotton instead of soil around the grass roots. Observations were made under the binocular microscope. They crawled hurriedly back and forth over the roots, into one crevice after another, seeking for the necessary dirt for a home. This frantic search continued until they became caught in drops of moisture or were otherwise stopped. There seemed no doubt that the first instinct, that of forming a cell, must be gratified before food could or would be taken, and the idea of a soilless cage was abandoned.

Newly emerged nymphs, dropped on the surface of the soil, soon disappear into cracks or crevices and readily find their way beneath the surface. A more desirable way of transplanting, however, is to remove one side of the glass cage and drop the nymphs upon the uncovered surface directly over the root mass.

CARE OF LIVE CAGES. If the small cages are left lying on the side for a few hours, many cells will be found against the under glass, giving the observer an ideal opportunity to watch cell-forming and feeding habits. Cages should not be wet after the introduction of newly hatched nymphs until these nymphs have had time to form their cells. Two problems confront the caretaker when the new nymphs have been plated. The host must be kept in good condition and the tiny nymphs should be protected from predacious enemies if possible. With the hardy plants which are used exclusively now, the first problem may be solved simply by burying the cages out of doors with their tops level with the surrounding soil and leaving them in this natural condition. Only in extreme drouth is any care needed. However, cages containing dozens of nymphs thus buried in the open have been entirely depleted in a short time by predacious enemies, probably largely by ants, while those kept in the laboratory were undisturbed. The problem of freeing the soil from animal life without using chemicals which will injure the cicadas when introduced, or by using treatment which will not injure the plants which must be hosts for them, is now being attacked.

COLLECTING LIVE SPECIMENS—ADULTS. To collect adult cicadas in the wild is a task requiring some skill and much time and determination, but to obtain observations on all their habits in the field would be a herculanean task. For museum purposes they may be killed with small shot shells, but to hope to get their story they must be taken alive. Some small species may be collected by sweeping. To take the larger and more wary kinds a long-handled net has been devised. The male may be found by his song, but careful scanning up and down the trunks and limbs of trees or other hosts is the only method of locating the females. No sure-catch methods have been devised. Sometimes they dart quickly out from the tree, sometimes to one side, sometimes to another. Again, if the female happens to be ovipositing, a quick sweep of the net may break her ovipositor, rewarding her captor with only a useless, mutilated specimen. However, a certain skill may be developed by practice.

LIVE CAGES FOR ADULTS. Live specimens of several species were placed in a wire cage on green limbs freshly cut from surrounding trees. Not a male sang, not a female oviposited, nor did a pair mate. Within two days all were dead, most of them having succumbed during the first afternoon. A wire cage containing a female *Tibicen dorsata* (Say) was then placed over a small walnut tree. Within a few minutes she was observed with her beak pressed against the bark obviously feeding. She lived several days in captivity feeding a large portion of the time. She also made several nice series of nests. It was assumed in succeeding work that all adult cicadas must feed if they were to live and function, and live specimens were always placed in cages over living plants or trees. A convenient form of cage is a mosquito net bag approximately a yard square left open at one end. This may be slipped over a twig or small tree or weed and tied shut. A small opening in the closed end makes a convenient place for inserting the cicadas, and may be pinned shut once they are inside. This type of live cage has given excellent satisfaction. It is inexpensive, collapsible, and can be quickly attached to any desirable host. Also, the soft material does not injure the excited captives when they strike it. Incisions can easily be made in this type of cage, if it is desirable, to make observations at closer range.

TRANSPORTING ADULTS TO THE LABORATORY. A pasteboard box with close-fitting lid is used to carry live adults from the field to the laboratory. Green pieces of weeds placed in the box give them something to cling to and reduce their nervousness materially. An attempt to transport live adults 200 miles in a mosquito net bag over a live transplanted tree in an open car was most disappointing. Many were dead at the end of the trip, and all died within the next thirty-six hours without having given any records. A few weeks later, however, a similar number were carried about the same distance in a heavy pasteboard box about 18x18x24 inches filed with green twigs. While some of those died in transit, some of all species represented remained alive. When put in live cages the males sang, both sexes fed, mating was observed, and many eggs were laid. One male sang lustily for three weeks.

MAKING OBSERVATIONS IN CAGES. If one moves quietly and slowly about the cages, the captive cicadas pay little or no attention, and all the normal habits may be observed at length. Photographs of captives have been made by cutting a hole in the netting and folding back the edges to allow better lighting and unobstructed view for the lens. It was found desirable in such attempts to work rapidly but quietly and gently, for the least disturbance would stop the operation and even if undisturbed the cicada might cease when the nest was completed. Prolonged observations have also been made by placing a live cage on a table out of doors and clamping the binocular to the table. Numerous ovipositing females have been observed in this manner.

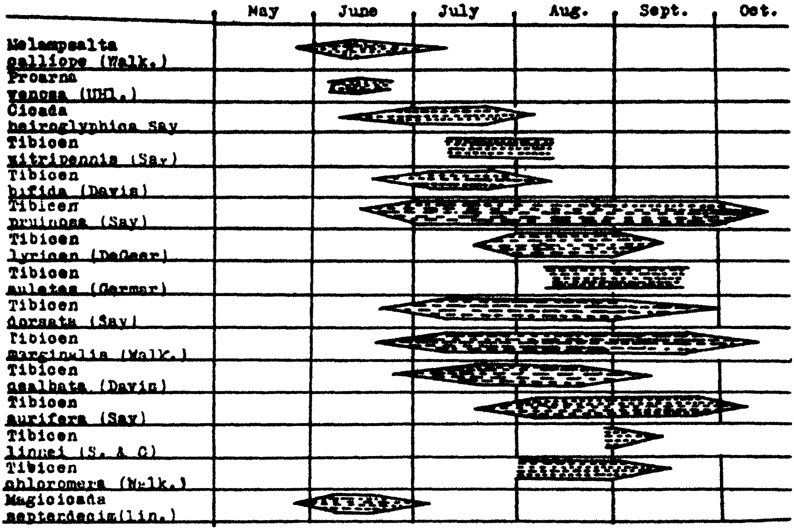
REMOVING ADULTS FROM CAGES. Cicadas in copula may be removed from the cage by picking them up in the hand and placing them wherever desired. They seem to have no fear, and may be placed in the open and moved about at will.

If it is desirable to remove females which are ovipositing from the cage, extreme care is necessary, and, even with the utmost care, only a small percentage of trials have resulted in success. When this was contemplated, dead sticks or live twigs, whichever was the normal host, were placed in the cage in a manner to be removed easily.

GENERAL NOTES.

BROODS. Queer, indeed, would be a Kansas summer without the songs of a half dozen species of cicadas. Although they are always with us, they rarely appear in sufficient numbers to be generally thought of as broods. Even then great numbers occur only in restricted localities. A few of these, however, are perhaps worthy of note. *Cicada hieroglyphica* Say emerges almost every year in blackjack oak, *Quercus marilandica,* in the southeast section of the state. A fairly large brood came out in June, 1926. In an isolated valley near Woodbine, Kan., a large brood of *Tibicen auletes* (Germar), emerged in 1923, and about one-half as large a brood in 1924, with practically none in 1925 and 1926. A noticeably large brood of *Tibicen lyricen* (DeGeer) emerged near Garnett, Kan., in 1923. It has not occurred there in so great numbers since. Our commonest eastern Kansas cicada, *Tibicen pruinosa* (Say), emerges in what appears to be almost constant numbers each season. The other species occur in varying numbers and places, some every year and others perhaps not so often, at least in the same localities. Thus while *Magicicada septendecim* (Linn.), the most famous member of the family, is represented by only an occasional herald one year, appears in countless number the next, a few lone stragglers the third, then the species disappears altogether for a number of years, apparently all other species which occur in Kansas appear in greater or less numbers every year, and no other species has been observed which approaches *Magicicada septendecim* (Linn.) in the density of one brood. There seems no reason, however, to question that each species of cicada requires a definite number of years in which to complete its cycle, just as the seventeen-year one.

There is considerable variation in the time of emergence of different species of cicadas. The early species emerge in June and July, the late ones in August and September, while others appear in varying numbers throughout the season. Emergence time is constant from year to year with a species in a given locality, but does not hold for other species of the genus. Thus while *Tibicen bifida* (Davis) appears in June, *Tibicen aurifera* (Say) occurs in small numbers throughout the summer, being one of the last to cease its song. The following table illustrates roughly the time of emergence of the species:



LENGTH OF LIFE OF ADULT. No data have been obtained on the length of the life of the adult individual in the field. Specimens have been kept in captivity from a few hours to three weeks. It seems probable that some species will live nearer their normal life in captivity than others. A male specimen of *Magicicada septendecim* var. *cassini* (Fisher) taken before it had completely hardened, lived in a live cage on cherry for two weeks. A male of *Tibicen dorsata* (Say), which had been taken when active in the field, transported 200 miles, and placed in a live cage on apple, lived three weeks.

EMERGENCE FROM THE SOIL. Emergence from the soil in every case observed has been accomplished through a more or less regular hole. Only in rare cases has there been a semblance of a hut or a cone, as is sometimes the case for the seventeen-year cicada. The normal time of constructing the emergence chamber has not been computed. A *Melampsalta calliope* (Walk.) fifth-instar nymph, dug its cell to within one-fourth inch of the surface twenty-six days before it emerged. No period of resting was detected, the nymph being observed at the bottom of its cell feeding shortly before transformation. One *M. calliope* (Walk.) fifth-instar nymph, transplanted from the field to a cage, emerged in ten days from a well-developed underground chamber which it had constructed. (Pl. XXXIII, Fig. 6.)

TRANSFORMATION TO ADULT. Observations have been made on the actual act of transformation from the nymph in but one species. However, dozens of cast skins of numerous species have been collected. Small species like *M. calliope* (Walk.) tend to cast their skins much nearer the emergence holes than larger ones. All seem to prefer night as the time for transformation. No variation has been noted in the way the skin splits or the method of holding to the support. The nymph comes to rest in a vertical position with the head up, or in a horizontal position on the underside of the limb, attaching itself firmly by the middle pair of legs.

FOOD HABITS OF THE ADULT. All data tend to show that adult cicadas of both sexes feed regularly and often. Both *M. calliope* (Walk.) and *Proarna venosa* (Uhl.) have been observed to feed between the making of nests during oviposition. A female of the latter species was seen to insert her beak into a stem of dry grass in which she regularly oviposits. Whether she obtained any food from it or not it was not possible to tell. In every instance the first thing the adults were observed to do when placed in a live cage was to feed and, given food, most of the species obtained mated, the males sang, and the females oviposited in captivity. In all cases where food was withheld the adults died within forty-eight hours at most.

THE SONG. All of our Kansas cicadas have individual songs, with the exception of *Tibicen dealbata* (Davis) and *Tibicen marginalis* (Walk.). Their songs seem to be identical. That the song of the cicada is a secondary sexual character has been generally accepted. No record has been found of observations of females following the songs of males, but two interesting types of experiences are given where females have been attracted by rhythm similar to the song of the male of the species. Mr. Annandale, writing on "Insects of the Skeat Expedition to the Siamese Malay States," in 1899, says:

> "At certain seasons this cicada, *Dundubia intenerata,* forms a regular article of diet among the Siamese inhabitants of Patalung; and as their method of capturing it is based upon a knowledge of its habits, I cannot do better than give an account of this method, as I saw in operation at Ban Nah, a village on the border of the hill country of Patalung. Immediately after the sun had set several of the natives gathered in an open space, round a fire of brushwood or a number of torches fastened to stakes stuck into the ground, and commenced to clap their hands in unison, observing a regular time and rhythm. Very soon, if they were fortunate, the Cicadidæ flew out from the undergrowth of the surrounding orchards and jungle and alighted on the persons of their captors, who had no difficulty in picking off the insects with their fingers and securing them, still alive, in the fold of their draperies. The clapping only continued for about half an hour every evening; and when, with considerable difficulty, I persuaded the men to recommence it again later in the night, not a single cicada came near them, though the stridulating had now become loud all over the village, like the noise of machine hair-brushes in a barber's shop.
>
> "The insects were silent on the wing, and I only heard one stridulate when caught. The voiceless females, as might be expected, were in great preponderance over the males among the specimens taken; probably the one individual which was not dumb when captured was the only male taken that night. In order to be sure that the fire was not the chief attraction for the Cicadidæ, I stood among a party of natives who were clapping, together with another member of the expedition, who clapped also, while I kept my hands still. In the course of a few minutes the natives captured many specimens, and ten alighted on my friend's coat; but only one settled on mine. Afterwards I heard from a Patani Malay that the children of Patani have a game in which they attract cicadas by clapping their hands, and without the aid of light at all; though they sing, as they clap, a nursery rhyme, calling upon the insects to come down from the trees."

A personal experience lends similar evidence. Numerous *Tibicen dorsata* (Say) females were collected on the cab and other parts of a Fordson tractor which was being driven through a weed-grown field. Not a male was taken. Persons have been known to mistake the song of this cicada when quite near for the hum of a distant tractor, and it seems reasonable to suppose that the sense organs of the female which record vibrations recognize a similarity in the two sounds. In both instances the females of only one species were attracted, although other species were present in the localities.

Perhaps the most direct proof of the relation between sex and song is the fact that in captivity the other males in a cage almost invariably sing when a pair is mating. They have been observed crawling around and over the mating pair singing with all their might. Not only one male, but several at a time, will react in this manner.

That the males also detect sound is indicated by the fact that singing in one cage provokes the singing of males in adjacent cages, even when they are of different species. It was also noticed that the singing of males in cages often excited answering songs by males in neighboring trees and, *vice versa* songs within hearing of the cages were answered by captive males. Likewise one male may break the silence on a summer afternoon to be joined almost immediately by males on surrounding hosts.

MATING. Matings occurred frequently among the cicadas in the live cages. Often several pairs would be in copula before the specimens arrived at the laboratory from the field. The act of copulation takes from a few minutes to an hour and a half. The same female often mates with different males. In one instance a male *Tibicen pruinosa* (Say) mated with a female *Tibicen chloromera* (Walk.). This occurred while transporting a number of species together in one container. Mr. W. J. Rainbow writing in Rec. Austral. Mus. v, p. 116, gives an account of the mating of two cicadas belonging to different genera. He also includes a photograph of the pair.

During the act of copula the pair seem to pay no attention to their surroundings, and may be removed from the cages for photographs or other observations.

OVIPOSITION. The mechanics of oviposition is practically the same for all species. As the abdomen is raised from the support the ovipositor springs from the protecting valves. The point is placed against the host at a right angle to it, and by a rotating motion of the whole organ and an in and out motion of the two valves it is gradually driven into the tissue. As it pierces the material, the angle is lessened so that the hole turns down, finally parallel with the surface instead of directly into it. When sufficient room is made for the nest, the process of placing the eggs is begun. These are laid usually in two rows the full length of the nest. The bottom end of the egg is placed at the back side of the cavity and the outer end against the outer side. (Pl. XXXI, Fig. 3.) There may be one or more nests made from the same external opening depending on the species.

NESTS. The nests may or may not be arranged in a definite order in the host plant. *Tibicen aurifera* (Say), *T. marginalis* (Walk.), *T. dealbata* (Davis), *T. vitripennis* (Say), *T. dorsata* (Say), *Melampsalta calliope* (Walk.), *Proarna venosa* (Uhl.), and sometimes

Tibicen bifida (Davis), exhibit an orderly arrangement of their nests, while the others noted scatter them more or less at random. Except in the use of grass stems, regular arrangement tends to be found where green tissue is used, irregular where dead.

Some species make use of secreted gluelike material both at the beginning and closing of a nest. *Proarna venosa* (Uhl.) exudes a liquid on the dry grass stem when she places her ovipositor against it. Again as she withdraws the ovipositor from the nest, she fills the opening entirely with a white frothy material. *Tibicen lyricen* (DeGeer) not only fills the opening full of secretion, but presses the torn tissues back into place with the fleshy sheaths of the ovipositor, leaving the external evidence of the nest difficult to see. Unlike the above, *Melampsalta calliope* (Walk.) does not place any secretion in her nests. This omission may account for the fact that her eggs shrivel as soon as the host begins to wilt.

EGGS. The number of eggs in a nest varies from three in *Cicada hieroglyphica* Say, to as many as twenty in some *Tibicen aurifera* (Say) nests. The arrangement of the eggs of most of the species follows that shown in (Pl. XXXI, Fig. 3) *Melampsalta calliope* (Walk.), however, sometimes uses a different arrangement. (See Pl. XXXVIII, Fig. 4.) In the stems of sweet clover, at least, she places her eggs in a fan-shaped figure, starting as low as convenient in the hollow stem and placing one egg on top of another up to or a little above the entrance of the nest. Cicadas which oviposit in different types of tissue may be influenced in the size of the nest by the nature of the nest. Mr. Wilman Newell writes in the U. S. Dept. Agri. Bureau of Ento. Bull. 60, pp. 52 to 58, of *Tibicen vitripennis* (Say) placing 75 eggs in a hollow stem from one opening. *Melampsalta calliope* (Walk.) regularly places from 12 to 16 eggs in a nest in asparagus or sweet clover, but only three in the stems of the compass plant, *Silphum laciniatum* L.

HOSTS. No species has yet been observed which uses only one host for oviposition. Attempts have not been made to list those used by any of the species because observations tend to show that they will use almost any material. Mr. Newell, writing in the report mentioned above, records *Tibicen vitripennis* (Say) ovipositing in the walls and roofs of sheds, in fence posts, in all kinds of weeds, in cotton, in corn, and even in the handles of hoes left in the field. Some one has observed a cicada attempting to oviposit in an iron bar. *Tibicen pruinosa* (Say) has been observed in the laboratory ovipositing in the wooden side of a cage. A species may show a marked preference, however, for some particular material. It may be anything from soft green weed stems to the very hardest of dead oak twigs. Although some species seem to prefer hard wood, the majority choose softer materials. The old corky bark of elm and willow is a favorite. Partially decayed twigs are also used. Plants with a pithy or hollow center, as sweet clover, cotton, corn, etc., are chosen by some species. While most species prefer either live or dead tissue, practically all will use the other if their preference is not at hand. *Tibicen pruinosa* (Say) and *Cicada hieroglyphica* Say have not been observed to oviposit in living tissue. Where twigs are chosen for nidification they are usually of a size convenient for the cicada to grasp with her legs.

EFFECT OF OVIPOSITION ON THE HOST. Where oviposition occurs in green tissue, the death of the stem sometimes follows. Newell reports a total loss of some cotton fields in Louisiana in this manner. In July, 1925, a field of cotton was inspected in Oklahoma by the author, where perhaps one-tenth of one per cent of the plants had been killed or severely injured by the oviposition of *Tibicen vitripennis* (Say). *Tibicen dealbata* (Davis) in western Kansas often oviposits so thickly in cottonwood twigs that the twigs die, either directly from the maceration by the ovipositor, or are so weakened that the wind breaks them off. It is no exaggeration to say that this species often cuts in shreds limbs one-fourth inch in diameter for a space several inches in length. Unlike the seventeen-year cicada, none of the species so far studied, except, perhaps, *Tibicen vitripennis* (Say), become numerous enough to be of any considerable economic importance in this way.

EGGS. The eggs of the different species of cicadas vary in appearance only as to size. Those of *Tibicen auletes* (Germar) measure about 2.75 mm. in length and .5 mm. in width, while those of *Proarna venosa* (Uhl.) measure about 1.6 mm. in length and 0.4 mm. in width. The chorion is smooth, shining, and transparent, revealing the internal structure distinctly as the embryo develops. The eggs are white in color and somewhat spindle-shaped, a little more sharply pointed at one end than at the other.

The length of the egg stage varies from one to three months in those species which hatch the same summer, and from nine to twelve months in those which hatch the following year. Among the species studied which oviposit in live tissue, *Melampsalta calliope* (Walk.) is the only one whose eggs wither with the wilting of the host. In all the others, even though the host dried, the eggs remained in perfect condition, if they were kept in outdoor conditions of temperature and moisture. Marlatt, in Bull. 71, U. S. Dept. of Agri., pp. 111, in discussing the eggs of the seventeen-year cicada writes as follows: "As is the case with most insects that oviposit in the living parts of plants, the eggs of the cicada receive a certain nourishment from the plant and actually increase in size before hatching, by absorption of the juices from the adjacent plant cells." Of the species studied *Melampsalta calliope* (Walk.) is the only one which could possibly obtain nourishment from the host, as the others, even if placed in green tissue, are capable in themselves of developing and hatching normally though the host dies. The eggs of all species show red eyespots, and later tarsal claws on all the legs, some time before hatching. In those of *Melampsalta calliope* (Walk.), *Tibicen bifida* (Davis) and *Tibicen vitripennis* (Say) the whole egg turns pink and the first instar nymph is pink after hatching. Fabre refers to those he studied as resembling a grain of wheat in color. All others studied remain white.

HATCHING. As has been mentioned earlier hatching appears to be influenced by moisture and temperature. A few stems containing eggs were left dry in the laboratory, while the remainder were moistened daily. When the hatch was practically complete in the moist stems and had not begun in the dry ones, these latter were dipped in water for a few seconds and then placed in warm air. Within an hour the eggs were hatching rapidly. A cool day during the hatch has also been noticed to stop the emergence temporarily.

In hatching the embryo bursts the egg capsule anteriorly and wriggles its way to the nest opening. The complete hatch of a dozen or more eggs is accomplished with little or no disarrangement of the empty shells. Usually the egg nearest the opening hatches first, and the others follow in inverse order to that in which they were laid. This is not invariably true, however. When the nymph emerges from the nest, it is still inclosed in the postnatal skin—a very thin, transparent membrane. Although the appendages are each incased in a separate sheath, all are folded ventrally against the body and remain stiff-jointed and useless until this skin is cast. The emerging nymph reminds one of a fish, both in general shape and in the wriggling motion by which it works its way along. The postnatal skin splits dorsoanteriorly. This is accomplished by repeated contracting and expanding of the body, which resembles an undulating motion. The anterior end becomes greatly distended, then reduced. So transparent is the skin that the only evidence of its splitting is the appearance through the slit of the hairs of the nymph. Gradually the antennæ are pulled free from the skin, then the front pair of legs. They immediately begin moving these large, digging front claws, opening and closing them. Within a few seconds all the legs have been freed and the abdomen slips easily from the wrinkled skin. When the eggs are hatching normally, it requires about five minutes from the time the anterior end of the embryo appears in the nest opening until the first instar nymph crawls away. The postnatal skin remains attached to the nest. The individual which is casting its skin may be projected entirely above the nest from the anterior end of another egg. Even the second nymph has been observed forced clear of the nest by the third. Only one casts its postnatal skin at a time, however, and when the hatch is completed the cast skins are grouped about the nest entrance. These appear to the naked eye to be tiny funnels, but a careful examination reveals a complete exuvium.

Occasionally the egg may be turned wrong end to in the nest and the emerging nymph fails to find the nest opening. Where nests are made in hollow stems, *Tibicen aurifera* (Say) nymphs have been found two or three inches down the stem searching in vain for a way out. Eggs removed from the nest usually do not hatch. This is probably due to the lack of support to hold the shell while the embryo breaks it. However, nymphs falling from the nest opening before casting the postnatal skin have been observed to wriggle continuously until they finally free themselves. This requires much longer than when it remains attached to the host, and a little excess of moisture in the receptacle or air which is a little too dry is fatal to the nymph.

Much variation has been experienced in the rate of hatching. *Tibicen aurifera* (Say) has been observed hatching so rapidly that the tiny white forms resembled scattered aphids on the stems. As many as 600 newly hatched nymphs of *Tibicen dealbata* (Davis) have been removed from a handful of twigs in one day. On the other hand, just an occasional postnatal skin or empty eggshell in the nests marks the hatching of one egg at a time in other species. Usually with the eggs in the laboratory the largest hatches come near the beginning, the number soon dwindling to only a few. Examinations of the nests indicate that all of the eggs of a nest rarely hatch in one day, but that in nests with large numbers of eggs most of them hatch within a few hours. The one or two remaining eggs may wait several days before hatching.

Among the species observed the hatching period of the eggs is much shorter in those which overwinter in the egg stage than in those which hatch the same season laid. Thus, while the nymphs of *Tibicen aurifera* (Say) emerged within a period of eleven days, *Tibicen bifida* (Davis) has been observed to hatch over a period of fifty-one days. It seems probable that this great variation in the time of hatching may be due to the difference in the time of oviposition. The development in the eggs which overwinter appears to be complete when spring comes, and all eggs of all species are ready to hatch as soon as the temperature becomes high enough for the last phases of development, regardless of the time laid. Thus *Tibicen dealbata* (Davis) eggs laid in July began hatching only three days earlier than eggs of *Tibicen aurifera* (Say), which were deposited in September. They all hatch within a few days of each other. Development may be accelerated by bringing the eggs into the warm laboratory early in the spring. Unless the nests have been parasitized or have been exposed to extremely arid conditions the percentage of eggs which hatch is high. In fact, examination of numerous nests often shows 100 per cent emergence.

IMMATURE STAGES. The newly hatched nymph with its front legs so peculiarly adapted for digging, its large antennæ, and hairy appearance in general, presents a really grotesque figure as it scrambles away from the nest. These are quite active as compared with any of the other instars, running about over the twigs which contained the nests or over the bottom of the tray, as the case may be. As other writers have said, the nymphs hatching in nature rush over the sides of the limbs and cast themselves into space as though the wings of their progenitors would bear them safely to the earth. It is here, no doubt, that the wind plays an important role in the distribution of the nymphs beneath the trees. As has already been stated the north side of trees seems to be the most likely place to dig for immature stages. The fact that our prevailing winds are from south to north agrees with these findings.

In the laboratory, at least, the nymphs seem to be attracted by moisture, although a cage with the soil too wet tends to repel them. However, the tiny individuals fresh from the nests are extremely sensitive to desiccation. But a few minutes subjected to dry air is sufficient to kill them. In order to make observations of nymphs under binoculars they must be placed on a moist pad. In a dry container one can watch the tiny creatures shrivel and die, the process taking scarcely longer than it does to write these words.

Newly hatched nymphs are phototropic, but after they have entered the soil light does not seem to affect the nymphs in any way, either in this instar or any other, when once an individual has its cell finished. Even though a part of the cell is glass and the light comes in freely, the nymph will often continue feeding for weeks without changing its home or showing in any other way what might be construed as a reaction toward light. Even when a strong electric light is thrown on them for observation, no reaction whatever can be noticed.

Unlike all the other instars, this is not affected by a sudden jar or other disturbance. Nymphs may be transferred from a tray to a cage by shaking the container over it, and, though they may fall a foot or more, all of them, upon touching the soil, will be moving. In the other instars there is a tendency to "play possum" when disturbed. The baby nymphs pay not the slightest attention to one another. If gathered together in a small space they will scramble over and over each other without injury, while the individuals of the other instars, if placed together, will soon kill one another.

NEWLY EMERGED NYMPHS. Newly emerged nymphs, upon reaching the ground, crawl about until they find a crevice which they can enter. They have never been observed attempting to dig from the surface in the laboratory although Fabre records nymphs digging beneath the surface, leaving openings which resembled pin holes. Excellent opportunity to watch their first operations has been afforded by the use of the small glass-plate cages. Many nymphs of different species have been observed during the first few hours of nymphal life and the actions are so characteristic, so alike in all essentials, that it seems safe to give a generalized description which may be applied to all. Occasionally the first crevice entered does not please the newcomer, and it returns to the surface and crawls about until it finds another. Within a few seconds, however, it has disappeared. The only exception to this rule is found when nymphs have been exposed to excessive moisture. If they have fallen into the water when hatched, or, if the soil is saturated with water, they remain above ground until a normal moisture content is reached.

UNDERGROUND. Underground the nymph is an explorer whose only compass is an instinct to go down. It wends its way through numerous openings, over roots, through narrow passages, feeling ever with the long antennæ. Occasionally it stops to remove a load or two of dirt from a narrow place, always being careful to place what it has removed in some other part of the passage. In a short time it finds a plausible site for a home and begins work in earnest. Using its highly modified front legs as pick and shovel, it is well fitted for the task. Tiny particles of dirt are picked from the side of the tunnel and either pressed against the postclypeus or in a ball between the front legs until a load has been amassed. This load is a ball with a diameter about the same as the head of the nymph. It may carry this dirt stuck fast to the cephaloventral side of its body with or without the support of one front leg, or between its two front legs. It is usually carried to a distant part of the proposed cell where it is forced against the wall and smoothed out with repeated clawing motions. At first it crawls on all three pairs of legs, with them in a normal position, but, once in the semblance of a cell, the second pair of legs are used over the back. It works usually in a tunnel small enough that all sides of it may be reached with its legs, yet large enough for it to turn over. A cicada nymph never turns around, it turns over. Hence, when it has its load of dirt, it backs back a step or more, if necessary, to reach a larger place, and, describing a partial somersault, crawls away in the other direction. After depositing the dirt it repeats the process to return to the other end of the cell. The cicada's idea of a home is a cell, cylindrical, smooth-sided, tightly finished. Within a short time it has one completed. Then, and not till then, does it appear to think of food.

A nymph will run over roots and pay no attention to them until it has constructed its cell; but it will complete a perfect cell in mud in a pan which has no roots in it. If a root happens to be near the cell, it is soon happily feeding. Numbers of nymphs have been observed feeding in the morning after having been placed in a cage late the evening before. However, if food is not available, it begins a search for it. This is the most laborious process imaginable. It keeps the cell complete always, moving slowly downward by removing the dirt from the bottom end of the cell and placing it carefully at the other end. This is continued until food is found or death overtakes the individual.

This instinct of observing such extreme care to keep the cell in perfect condition may not seem strange when one considers the dependence of the nymph on the prevention equally of desiccation and flooding. Not only will a nymph drown in a short time in water, but a newly emerged one is so light and so frail that it is unable to free itself from even a little excess moisture. After it is established, hard rains or even temporary flooding of the ground above may do no injury, but a light shower before the cell is constructed is disastrous. Again, when one considers that it is utterly defenseless if attacked by enemies, one must admit there is really a need for the care. The pincerlike claws are effective weapons when they strike their mark, but the blindness, slow movement, and lack of biting mouth parts seem to have been sufficient handicaps to the cicada in battle, so that its first reaction is nonresistance rather than pugnacity. Safety seems to lie in not being found. Judging from the pitifully few nymphs which develop after the hatching of hundreds of eggs, one feels that the precautions are none too great. This exceedingly high mortality is probably due largely to predacious enemies. Ants, no longer than the nymphs themselves, have been observed carrying away the helpless cicada, and cages in which nymphs have been placed have been found worked into fine particles by ants and other predacious animals. In such cases the most diligent search reveals not a single living nymph.

When searching for food the cicada feels constantly with its antennæ, and, when a root is encountered, claws at it with the front feet. The beak is inserted with some difficulty, the nymph apparently pushing against the opposite sides of the cell with the two hind pairs of legs. During feeding, the front claws remain idle, not touching the root. The body is usually nearly parallel to the root, though cases have been observed where the head was bent backward. When the nymph emerges from the egg the beak is straight and is carried close against the ventral side of the body. The above-mentioned cases of the head being held at an angle may possibly have been where the nymph was feeding for the first time and had not yet bent the beak, for in all his later life the nymph carries his beak bent between the front legs almost at a right angle to the body.

FIRST INSTAR. The length of the first instar apparently varies with the species. According to Marlatt, the seventeen-year cicada molts into the second instar in the second year, making the first stage perhaps eighteen months. *Tibicen vitripennis* (Say), in the laboratory, molted the first time in six weeks. It seems probable that the length of the first instar may foreshadow to some extent the total life history of the species, although the data are, as yet, too meager to warrant definite conclusions.

The baby nymphs of most species are white in color, although some are pink. As to why some should be pink, no answer is apparent. The three species observed which have pink nymphs all hatch the same summer as the eggs are laid, but two other species, with similar habits, have white nymphs. It cannot be due to live or dead tissue in which the eggs are laid, because one species with pink nymphs oviposits in dead tissue while the other two use green. It is also interesting to note that the live tissue of one of the latter withers upon oviposition, while the other does not. This pink color appears to persist throughout the first instar, but is lost in the second.

The general shape of the body of the first-instar nymphs is more nearly cylindrical than in the next three instars. The head and pronotum are large and closely joined. The antennæ are over one-third the length of the entire body and about as large around as either of the back pairs of legs The segments of the antennæ vary in number in different species and sometimes apparently within the species. The beak is nearly as large as the front femur in diameter and almost a third as long as the entire nymph. The eyes are represented by granules of highly colored pigment showing through the epithelium.

The legs are long and strongly built, with the front pair remarkably modified for digging. The tarsi are two-jointed, with two long tarsal claws, usually of unequal length. The apex of the middle and hind tibiæ is set with a number of strong, nonsetæ-bearing spines. The apex of the front tibiæ is modified into a beaklike projection with or without teeth on its cutting margin. The front femur on the ventral side is armed with a short, sharp, median spine, and a much larger, often more or less bifid, basal, beaklike tooth. It is these adaptations of the front femur and tibia which so admirably fit these insects for their underground life. The whole insect is sparsely covered with hairs and spines of varying lengths and sizes. Just before molting into the second instar the abdomen becomes distended, thus changing the general appearance of the nymph. In molting the skin splits in exactly the same way as in the fifth instar when the adult emerges.

SECOND INSTAR. The second-instar nymphs are quite noticeably less active than the first. They are practically helpless when out of their cells. In color they are creamy white shaded somewhat with brown on the anterior half and the cutting parts of the front legs. The eyes, mere swellings on the side of the head, are always of the same color as the body, with the posterior half sparsely set with stiff hairs. The size of this instar varies considerably among the species, and some even within the species. The nymph now loses the cylindrical form which it presented in the first instar. The abdomen is much larger, tapering caudad and constricted anteriorly to meet the smaller thoracic segments. It also curls ventrally, more in some species than in others. This irregular form continues until the fifth instar, when the nymph again becomes nearly straight sided, due to the broadening of the thoracic segments.

The tarsal claws in many species lose all semblance of claws, becoming chitinous stubs, the anterior one usually very much shorter than the other. The large spines at the apex of the middle and hind tibiæ have large setæ projecting from their inner margin near the tip. The tarsus of the front leg has almost entirely disappeared. It is represented by a short, triangular-shaped segment so closely appressed to the anterior side of the tibia as to be practically indistinguishable. The whole tibia becomes more beaklike, and otherwise adapted for cutting and digging. The femur is further modified by the addition of a flat chitinous disc placed anterior to the median tooth. This has been called "the comb" by Marlatt. It is a flat, wedge-shaped piece with a varying number of teeth on its outer margin and is used in helping to shear the dirt from the sides of the cell. (Pl. XXXVIII, Fig. 8 [*d*].)

Unlike the first instar these nymphs show a decided reaction to disturbance. When they are rolled out on a heap of soil in the process of collecting them, it is some time before they will begin to move their legs in an effort to right themselves. This tendency to "play possum" is no doubt a protective measure. Frequently when a cell is broken into the inmate draws back from the opening and assumes a statuelike attitude, or perhaps first retreats to the depth of his cell and becomes quiet. In contrast to this is the pugnacious behavior encountered often when one opens a cell. Whether this difference in behavior is due to a difference in the nature of the disturbance as observed by the nymph or to a difference in temperament of the individual, it is impossible to say. Whatever the explanation, it has been observed that in a great many cases where a cell is opened without the nymph being ejected it rears up to the hole with both front claws raised for an attack. This attitude is not all bluff, as evidenced by the fact that it will grasp a stick or tweezers viciously if it comes in reach. So tenacious is it that it may often be lifted clear of its cell in this manner. No difference has been noted in the pugnacity of the different species studied, but nymphs which have been starved will generally show fight if disturbed.

The individuals of this stadium are very difficult to find in the field because of their small size and the fact that their cells are so small they do not break open in the tearing apart of the soil.

THIRD INSTAR. The third instar closely resembles the second. There is a substantial increase in size; the wing pads are noticeable; the comb on the front femur becomes larger, with usually an increase in the number of teeth, and the antennal segments may increase in number. The length of the stadium varies with the species.

FOURTH INSTAR. The fourth instar is almost an exact replica of the third, save an increase in size. Sometimes faint fuscous markings appear on the borders of the sclerites. There may be an increase in antennal segments; the wing pads are distinct, and there is an increase in size of the comb on the front femur, with an addition of teeth. The length of the stadium varies with the species.

FIFTH INSTAR. When the fifth-instar nymph draws itself out of the exuvium which has encased it, the head and thorax broaden markedly, becoming wider than the abdomen, which is now somewhat diminished. Throughout this stadium the abdomen never becomes as distended as in the three earlier stages. The body of the nymph thus retains more of a rectangular shape, with the sides of head, thorax and abdomen nearly parallel.

The nymphs of some species are also strikingly colored with fuscous. Wide borders appear on the dorsal abdominal sclerites, the pronotum, and the wing pads. The segments of the antennæ and legs, also, often have conspicuous dark markings. In some species the entire nymph becomes a light brown marked by a darker color, in others the body remains practically white but strikingly marked with dark, while in still others very little color appears.

The changes in the appendages are quite radical. The number of antennal segments may increase and some of the segments may change shape. The tarsi all become two-segmented. Those of the front legs are normal in size, but are bent backward on the inside of the tibiæ, thus being out of the way of the insect's digging activities. The tarsi of all legs have two well-developed tarsal claws, one usually slightly shorter than the other. The comb of the front femur becomes larger, and has additional teeth on its outer margin. The setæ-bearing spines of the middle and hind tibiæ usually increase in number. The genus *Proarna* is the only exception. This characteristic would seem to be of some generic value. The genus *Tibicen* changes from three in the second, third and fourth to five in the fifth, *Melampsalta* from two or three, and *Proarna* does not change at all.

The eyes in this instar are much larger and look more like eyes, although the posterior half is still covered with sparsely set hairs. The wing pads are long and show signs of tracheæ through the walls. Some little time before emergence the outline of the tarsal claws, spines, etc., of the adult may be seen through the nymphal skin. The eyes also change color in all the species noted. This fact is of great help in picking specimens which one knows will emerge in the next few weeks.

The fifth instar nymphs are decidedly more active when removed from their cells than any other since the first. The others can scarcely crawl on a flat surface, but tumble about awkwardly. This change is probably due to the better proportioned body. It is, of course, necessary, since the nymph must emerge from the soil and find a convenient perch for transformation.

ENEMIES. Perhaps the most conspicuous of the cicada enemies are the birds. Particularly noticeable is their ravage early in the season. Often within an evening the song of half a dozen males will end in the characteristic muffled squawk of the captive cicada, and an interested observer may see the bird flying away with its prey. Marlatt records the complete annihilation by birds of a brood of seventeen-year cicadas which had been artificially transplanted to a new locality and had emerged in great numbers.

Perhaps equally destructive, if a little less easily seen, are the large digger wasps, *Sphecius speciosus* Dru., or cicada killers. A comprehensive and detailed account of the habits and life history of this wasp has been given in Marlatt's paper. Cicadas appear to be aware of these enemies but rarely. Usually the wasp seizes it from behind, and together they fall to the ground where the cicada is stung until it is quiet. The cicada is utterly helpless when overtaken, but individuals have been observed to fly away when a wasp approached, and thus escape capture.

While birds and cicada killers are frequently observed taking the large, tree-loving species, the smaller cicadas have still other enemies.

Large robber-flies (Asilidæ) have been observed carrying away *Cicada hieroglyphica* Say, *Tibicen aurifera* (Say), *Melampsalta calliope* (Walk.) and *Proarna venosa* (Uhl.). These have also been found in the jaws of large spiders or securely fastened in their webs.

The adult cicada has still another type of enemy. Two different species of Sarcophagidæ (flesh flies) have been bred from the bodies of cicadas, and there are doubtless others which use them as hosts when opportunity offers. It is not an uncommon sight when collecting cicadas, especially of the prairie-loving forms, to see one or two flies follow a cicada when it takes wing. This is easily seen if the cicada happens to fly in just the right direction in regard to the sky line. The flies follow but a few inches away, and sometimes seem almost to alight on the body of the cicada.

In the egg stage clever little parasitic Hymenoptera cause great havoc in certain species. In some cases fully fifty per cent of *Tibicen aurifera* (Say) nests collected have been found to be parasitized, and a single grub normally consumes an entire nest of eggs. Similar parasites have also been reared from nests of *Melampsalta calliope* (Walk.) and *Tibicen marginalis* (Walk.), although so high a per cent of parasitism has not been observed in nests of these species. Grubs have been found in the nests of *Tibicen dealbata* (Davis) also, but the adults have not yet been obtained. Other writers have described and illustrated numerous species of mites which are also parasitic on the eggs of cicadas. No attempt has been made in the present work to study this group, but numbers have been observed in and about the nests of various species, and eggs have been noted which have the appearance of having been sucked dry by them.

From the time the tiny nymph crawls from the postnatal skin until it bursts its fifth instar skin and emerges as an adult, it is prized as food by various predacious animals. Ants have been observed on the twig bearing nests waiting to devour the nymphs as they hatch. In the soil, dismembered bits of small cicadas have been found in their jaws and scattered remains have been observed along their runs. No actual evidence has been obtained, but circumstances and the habits of the groups would suggest that chilopods and other forms of similar habits, doubtless play no small part in the control of cicadas.

Marlatt writes interestingly of the habits of hogs rooting up the ground where seventeen-year cicadas are about to emerge and feasting on the nymphs, and of dogs and chickens and other domestic animals eating large numbers of the emerging ones. During excavations for seventeen-year cicadas, attention has been attracted frequently in this work to mole runs along the under side of roots near the surface of the ground. Where one is encountered it invariably runs the length of the root and never has a nymph been found under these roots, although they may be found in numbers only a few inches away.

MORPHOLOGY.

No attempt has been made to treat the morphology of the cicadas in an exhaustive manner. Drawings of the external parts of the adult, which are self-explanatory, have been made of *Melampsalta calliope* (Walk.). (Pls. XXXV and XXXVI.) A series of drawings of the external development of the genitalia of the sexes in so far as it could be followed is also included. (Pl. XXXVII.) Attention is called to Pl. XXXVII, Fig. 8, in which the œdagus hooks show through the body wall in the tenth sternite. This can be seen only in individuals with red eyes. No trace of the internal genitalia could be found in the fifth-stage individuals with normal eyes.

Melampsalta calliope (Walk.).

Because more data have been obtained on its habits and life history than on those of any other species, *Melampsalta calliope* (Walk.) is here considered first. Both adults and nymphs have been collected in greater numbers, and rearing experiments have been more complete in this than in other species.

This is one of the smallest of Kansas cicadas, measuring 12 to 15 mm. in length. In color it ranges from green to brown with an occasional pink specimen. The color seems to vary somewhat with the locality, those taken in Scott county being uniformly green, while those of other localities are usually light brown.

DISTRIBUTION IN THE STATE. This species occurs in every county in the state. Wherever prairie meadows are found, there one finds *Melampsalta*. There are, however, three localities which deserve special mention. The first of these is on the ranch of Mr. Herbert Steele, located in the Beaver Creek valley 14 miles north of Scott City, Kan. The particular location is a small, flat-bottomed draw perhaps 75 yards long and 50 yards wide, a short distance east of Mr. Steele's house and extending back from the creek itself. (Pl. XXIX, Fig. 1.) Although this depression is scarcely five feet below the surrounding land, the vegetation is very much heavier. It was here, in June, 1925, the adults were found ovipositing in goodly numbers. Upon examination of the soil, it was found to be fairly teeming with nymphs of all stages, as many as fifteen having been found in one spadeful of sod. (Pl. XXIX, Fig. 2.) Of the hundreds dug here but two or three proved to be of another species, although four other species were collected in the valley at this time. It was from this location, about 400 miles by automobile from the laboratory, that most of the data on transporting nymphs alive were obtained.

The second location is a wild-grass meadow about 11 miles west of Lawrence on the road to Topeka, Kan. (Pl. XXVIII, Fig. 2.) The adults were observed ovipositing here, but no digging was done, as it was very stony soil and the meadow was mow land. This was a convenient place, however, to procure adults for cage experiments.

The third locality is a draw in the hills about one and a half miles southwest of Belvidere, Kan. It is noted for the adults collected there in 1923, when it was possible to capture 25 or 30 adults in a few strokes of the net. A visit to this same locality in 1925 failed, however, to reveal the nymphs one would naturally have expected to find. The adults had been many times thicker than in the locality in Scott county, where one could get but one or two specimens in twenty strokes of the net. This seeming high mortality may be accounted for by fires which destroy the eggs before hatching, or floods which bury and thus kill the vegetation of these flat valley-floor habitats.

HABITAT. This species is decidedly a lover of meadow land. It is practically never associated with trees. An unkempt roadside, small valleys among rocky hills, or any other land growing wild perennial grasses and weeds, unmowed and rarely burned over, makes an ideal habitat. Here both sexes find food in abundance and the females plenty of pithy stemmed weeds for oviposition, while the nymphs pass the long underground life feeding on the roots of the plants. (Pl. XXVIII, Fig. 2)

BEHAVIOR. This is not what one would term a wild species, although during the heat of the day they take flight readily. The females are very tame while ovipositing, paying little attention to anything else. The stems upon which they are working may be carefully cut off and the specimens moved about at will for observation and photography without disturbing them in the least.

The best method to locate the adults when entering a new locality is by sweeping the vegetation with a net, as the specimens are small and colored very much the same as the plants upon which they live. Unlike most other cicadas the males do not sing loud enough to be heard for more than a few feet. It is possible when one becomes familiar with this species to walk through a likely place watching the hordes of insects fleeing ahead and to pick out the cicadas and often notice where they alight. This is usually not far away unless a strong wind is blowing. Walking toward the wind will often help, as the individuals will not fly so far against the wind as with it. When this method is being used, walking in a certain direction with regard to the light will also be found advantageous.

EMERGENCE. The emergence in the field begins the latter part of May and is well over by the first of July. They come out at night, as do other cicadas. The emergence hole is somewhat irregular, and only in rare cases does it show a tendency toward a cone (such as is made in some cases by the seventeen-year cicada). This is never raised more than a bare fraction of an inch above the level of the ground.

In cages the first emergence took place on June 11 and the last on July 2. Here, also, there was a tendency to raise the edges of the emergence chamber above the level of the surrounding soil in a few cases. The tunnel was constructed to within a fraction of an inch of the surface of the ground several days before emergence in all cases observed, but no period of rest or fasting was detected. The nymphs seem to be active up to the time of emergence. One placed well toward the bottom of a small glass cage built a nice cell to the surface and emerged within ten days after being transplanted. This nymph was observed feeding on roots near the bottom of the cage the day before it came out.

A short time before emergence the eyes turn bright red, thus marking plainly those nymphs which are soon to appear as adults. In several instances after the eyes had turned red they again resumed a white color, and in a few days the nymph died. The most careful observations failed to reveal the cause of this relatively high mortality just before emergence time. In many cases the cell would have been completed to within a fraction of an inch of the top of the ground. Individuals have died in cages from which another nymph either had emerged, or did a few days later. Death could scarcely have been due to attack by external enemies, for it was foreshadowed by the loss of pigment in the eyes for some days before the individual succumbed. In fact, these individuals have been observed to be normally active and often belligerent when disturbed, Injury from transplanting would probably have been suspected, were it not for the fact that so large a number of empty shells had been found in cells near the surface, while digging for nymphs in the field, that it was considered that possibly these large forms had molted once in the cell. Rearing experiments show these must be the remains of nymphs which have died very much as the ones in captivity died. If red-eyed individuals are preserved the tarsal, claws, spines, etc., may be seen through the nymphal skin Thus we have another mark of approaching maturity.

FEEDING. The adults in captivity feed within twenty-four hours after emerging. They feed frequently at all times of day. They have been observed on so many different hosts that it has been considered they will use almost any living plant in their locality. In captivity they have been seen feeding on oak and asparagus—two plants not in their regular habitat.

MATING. The mating of this species was not observed in the field. One female emerging from a cage mated with a male brought in from the field the next day and deposited eggs that same day. While this pair was in copula another male in the cage crawled to within an inch of them and sang persistently.

OVIPOSITION. Many females have been observed ovipositing in the field. As has been stated above, they are less wary than most species, and may often be carried about by removing the stem upon which they are working. They will oviposit in almost any green plant but will make a far greater series of nests in some of the perennial weeds with pithy stems. (Pl. XXX, Fig. 1.)

The mechanics of oviposition is the same as that already described. There appears to be no secretion either at the beginning of the nest or at the ending. Neither does the female attempt to replace the shredded tissues of the host plant when the nest is completed. This species oviposits freely in captivity. Numerous nests have been placed both in sweet clover and asparagus. As has already been stated, a female which emerged in captivity mated and laid eggs the next day.

NESTS. The nests are regularly placed in one row up and down the stem. (Pl. XXXII, Fig. 2.) More than one row is sometimes found, but this is probably due to different females having used the same stem. The number of nests in a series may vary from one to thirty according to the nature of the host, whether it is hard or soft, to the condition of the female, and to whether she is disturbed. The nests give the stems a roughened appearance, and when they are closely placed weaken the stem, but they do not kill it. The eggs in a nest vary in number, from three in hard stems like the compass plant (*Silphium laciniatum*) to twenty in the pithy stems of sweet clover. The arrangement of eggs in the nest varies also with the kind of material of the host. Often this species arranges its eggs in a vertical fan (Pl. XXXVIII, Fig. 4) instead of in the regular way (Pl. XXXI, Fig. 3).

LENGTH OF LIFE. In the field no data have been obtained as to the length of life of the adult. In cages they have been kept for about ten days. Since the female that emerged in captivity mated and laid eggs the next day, it is reasonable to assume they do not live a great while even under the most favorable conditions.

ENEMIES. The adult cicadas of this species fall easy victim to a great many predacious enemies. The dipterous family of robber flies, Asilidæ, is perhaps the arch enemy, as a great many large species of this group are very common throughout the habitat of *Melampsalta*. The cicada flies so slowly that it is easy prey for these hawks of the insect world.

A great many specimens, too, have been taken from spider webs where they have become entangled and then wound up with silken thread. Not uncommonly specimens have been seen in the jaws of certain of our large spiders, no web having been used in the capture.

Aside from the predacious enemies, *Melampsalta calliope* (Walk.) encounters numerous vicissitudes such as haymaking, fire and floods. Such conditions probably play the biggest role of all in excluding the species from many localities. Eggs laid in a wild hay meadow are very often destroyed by the mowing of the meadow before hatching time.

Fire is another big hazard which this species must run. An accidental fire in the meadow lands where *Melampsalta* has oviposited obliterates entirely the year's brood in that locality.

Floods are also a very real menace to broods in certain lowlands. Flat-bottomed draws surrounded by prairie-covered hills often furnish the habitat desired by this species. In times of freshets great amounts of soil are carried down and deposited in these locations, often entirely covering and thus killing the vegetation. This, of course, destroys any eggs which are in the present growth and starves the nymphs of other broods which are feeding on the roots.

EGGS. The eggs of *Melampsalta calliope* (Walk.) differ from the other species of cicadas in appearance only as to size. They are 1.7 mm. in length and 0.31 mm. in width. When laid they are white in color, changing to pink before hatching.

MATURATION. The egg stage is about two months. Before hatching red eyespots appear and later the entire egg becomes pink. Female cicadas were observed ovipositing during June, and the eggs hatched in August.

Hatching The hatching of the eggs takes place in August of the summer they are laid. It probably continues about a month. This was difficult to ascertain because the eggs shrivel with the withering of the host, so that it was impossible to bring quantities of stems into the laboratory for observation. The eggs do not seem to hatch as completely as those of some of the other species Usually a few eggs in each nest appear shriveled. Probably the fact that they do not place a secretion in their nests after oviposition, but leave the eggs dependent upon the condition of the host, accounts for this loss

The first nests of eggs found in June, 1925, were collected, packed in boxes and mailed to the laboratory Examination a few days later revealed that the eggs were shriveling The next attempt to secure the hatching of eggs was made August 14, 1925, when stems containing eggs were again mailed to the laboratory These eggs showed red eyespots plainly, were pink in color, and the tarsal claws of the embryo could be seen through the eggshell They reached the laboratory August 15 The foliage of the plants had not yet withered and the eggs seemed in perfect condition A few eggs were hatching when they arrived, and they continued to hatch in the laboratory throughout the 15th and 16th The hatch was regular in every way, appearing identical with all other species observed For twenty-four hours these stems were kept in a closely covered jar to prevent withering of the hosts The evening of August 16 the laboratory assistant was called out of town and the stems were placed in the open over a pot of perennial grass Hence, no data were obtained as to how long eggs would have continued hatching in these cut stems if they could have been kept in humid conditions Examination of the nests two weeks later showed that a large per cent of the eggs had shriveled instead of hatching An attempt to find the tiny nymphs was made early in the spring of 1926 with no success, and fear was entertained that none of them had succeeded in finding food However another examination March 27, 1927, revealed four nymphs—three were third-instar nymphs and the fourth was still a second-instar nymph

In the summer of 1926 numerous nests of eggs were obtained in plants in the outdoor insectary from adults in captivity Since it was again necessary for the caretaker to be away during the time of hatching, large glass-sided cages were buried near these host plants in the hope of catching the tiny nymphs in them when they emerged Time must be allowed before the success of these attempts can be determined because of the difficulty of finding first- or second-instar nymphs in large quantities of soil

A number of newly laid eggs were removed from nests and placed on moist cellucotton in a vial These eggs appeared to remain in good condition, but maturation was not completed This stage of *Melampsalta calliope* (Walk) is more difficult to study than of any other species observed because of the extreme susceptibility of the eggs to the condition of the host.

Parasites A number of chalcid parasites belonging to the genus *Syntomaspis* were bred from nests made in sweet-clover stems. These have been identified by A. B. Gahan as the same genus and species as previously bred from the eggs of *Tibicen aurifera* (Say) (Ann Ent. Soc. of America, vol. XVIII, 1925, p. 483.)

NYMPHS.

FROM THE FIELD. Several hundred nymphs of *Melampsalta calliope* (Walk.) have been taken in the field. The greater part of these came from the locality in Scott county, Kansas. (Pl. XXIX, Fig. 1.) Interest in this locality was first aroused by the taking of adults of the species while sweeping in this glen. Although not many were taken in each series of sweepings, the adults were soon observed flying away as the collector walked through the weeds. Careful examination of the herbage soon disclosed large series of nests in many of the weeds. Attention was then directed to scanning the weeds carefully for a female in the act of ovipositing. In a few minutes one was located, and the process observed first with the naked eye and later with a small hand lens. When attention was directed to the hunting of this one insect, it was not difficult to find, and several were observed ovipositing and feeding on as many different types of wild plants. So gentle were they that observations and photographs were made with ease in the open. Since an hour or so of work had been awarded by success in obtaining data on feeding habits and oviposition of *Melampsalta calliope* (Walk.) it was decided to try digging for nymphs.

A site was chosen near a plant with old oviposition marks on it. These were in dead stems which had remained standing, while new nests were always in green tissue. Almost the first spadeful of dirt yielded nymphs, and as many as fifteen individuals have been found in one spade of sod. (Pl. XXIX, Fig. 2.)

Usually the cell of *Melampsalta calliope* (Walk.) is not over an inch long where food is plentiful, although, if the plant on which a nymph has been feeding has died, the cells may become burrows extending many inches. In either case it is usually a simple matter to find the occupant if a cell is discovered, and using care thus first to locate the cells greatly reduces the danger of injuring the nymphs. The following notes taken in the field on this first trip may be of interest:

> "In digging for nymphs we soon came to recognize their burrows. The cells that contain the nymphs are usually only an inch or so long. One end is of the normal soil, while the other is stopped by some dirt cuttings which look much like fish-worm droppings. They occur mostly from six to ten inches beneath the surface. Only the largest specimens are found near the surface. These have large wing pads and doubtless would have emerged in a few days. One with large wing pads was down about eight inches, but it is different in coloring from those found near the top of the ground. We could arrive at no further conclusions as to age of the nymphs by the depth at which they occurred because all sizes were found at all depths. More nymphs are found where vegetation is thick. We could not tell which kind of vegetation they preferred. There was seemingly no difference or preference. A good many molted skins were found near the surface of the ground, which seems to demonstrate that the little fellow molts once after it has large wing pads."

From the first collection of nymphs made in June, 1925, about fifty specimens of all sizes were preserved in alcohol and as many more were packed in loose earth and mailed to the laboratory. When they arrived, two days later, just five specimens were uninjured. These all happened to be of the fifth stadium. Two of these were placed in a small glass-sided cage perhaps one-half inch thick with newly transplanted crab grass (*Digitaria sanguinalis*) as the host. Usually newly transplanted hosts make poor food for nymphs, but so quickly does crab grass recover from being moved that these nymphs seemed to thrive from the first. They began working on their cells almost immediately when placed in the cages. These were soon completed one-half inch in diameter and two and a half to three inches in length, with the long axis in a vertical direction. Often the glass was allowed to form a part of the cell for weeks at a time. The extent of the cell could be seen readily in this small cage by the difference in appearance where the dirt had been pressed firmly against the glass in making it.

The other three nymphs, received uninjured in this lot, were transferred to a pot of native grass. This pot did not have sufficient drainage and a heavy rain drowned the nymphs.

A second attempt to transport *Melampsalta calliope* (Walk.) nymphs from Scott county was made in August, 1925. This time they were packed in roots and leaves. They were mailed as soon as dug and reached the laboratory the next day. Within twenty-four hours after leaving their cells in the field they were digging new homes in the laboratory. Nineteen individuals of this lot arrived uninjured. Most of these had formed cells in the dirt about them and were in good condition. Specimens which had been injured were preserved for laboratory use. Of those put in live cages, several were lost by experimenting with them in cages of wheat. However, some interesting observations were made on habits of digging and feeding in the cages of grasses. August 30, 1925, a third-instar nymph was observed digging its cell. It cut the dirt loose with the front claws, packed it on the postclypeus until it had a ball about as large in diameter as its head, then holding it in place with one front claw, it backed to a wider place in its cell and turned over ventrally, describing a partial somersault. By means of its two hind pair of legs—one pair up and one down—it crawled off in the opposite direction. This placed the ventral side up where it had been down before, but the nymph paid no attention whatever to this, crawling as easily one way as another. When it reached the opposite end of its cell it deposited the ball of mud and smoothed it down with its front claws. This was repeated over and over, the action being the same in every detail.

September 2, 1925, a cage was examined which contained a small fourth-instar nymph. The grass was dead. The nymph had burrowed from end to end of the cage in its search for food, and was trying vainly to go deeper in a lower corner. Another cage, in which the grass was dead, contained a fifth-instar nymph. When the glass was removed in order to transplant new grass the nymph behaved much as a human might during a violent earthquake. It crawled rapidly to the top of its tunnel, then hastened down halfway, stuck its head and front claws out of the opening in the cell and appeared to be trying to detect in some way what had caused the disturbance, and to show fight if it encountered anything. So threatening was its attitude that a stem of grass was held close to it in the opening. It grasped the stem firmly, apparently trying to mangle it. Its alarm was very real. When the transfer was complete and the cage closed, it immediately settled back in its cell and resumed normal activity.

On September 16, 1925, a fifth-instar nymph was observed feeding. It was so located that its beak could be seen plainly without removing the glass. It happened to be standing with head downward and remained in this position feeding for forty-five minutes, holding very still. The front claws were suspended in the air, not grasping the root on which it was feeding.

A laboratory study of preserved material divided the nymphs into eight apparent sizes. Since it was impossible to prove what constituted a year's growth, or even to be sure what range of variation should be termed an instar, a series of experiments were planned to settle these points by rearing nymphs. A trip was made to Scott county, Kansas, in November, 1925, to obtain live material. This material was transported in layers of mud and live cages as described under technique of transporting live nymphs, page 162. There were no fatalities in transit. One hundred twenty-nine nymphs of the last four instars were collected. Eighty-nine of these were placed in a large pot of *Panicum virgatum* to insure future material. When the large pot was inverted on a table the contents remained intact, revealing almost a solid mass of roots, large and small, on the outside of the lump of dirt. (Pl. XXXIII, Fig. 3.) The nymphs were inserted in small holes made between the roots in the dirt and each cell capped with a flattened bit of mud. These nymphs were placed all around the pot and at varying depths, from three inches down to within an inch of the bottom. They were as follows: Size No. 8, 20 individuals; size No. 7, 25 individuals; size No. 6, 10 individuals; size No. 5, 20 individuals; size No. 4, 12 individuals. The sod was then replaced in the pot and left in the warm laboratory for 48 hours.

The remaining 42 nymphs were sorted according to apparent size, placed in cages, and records made of them. Only nymphs judged to be the same age were placed together. Usually not more than two fifth-instar nymphs were caged together, but as many as five or six of the small ones were put in the same cage. The host was orchard grass and had been growing for a month. The nymphs were kept in the laboratory for 48 hours. When examination showed that they had formed cells, they were buried in the open with the tops of cages even with surface of the ground and thinly covered with dead leaves.

These cages were unmolested until May 9, 1926, when they were taken into the laboratory for examination. A few nymphs were found dead where they had been planted; these were undoubtedly injured in collecting. A few others appeared to have died recently. In one cage the grass had died and the nymphs had starved to death. The soil was alive with other tiny animals, springtails, mites, fishworms, ants, sowbugs, etc. There was no evidence, however, that the cicadas had suffered from any of them. About 30 of the 42 original nymphs were found in the cages in apparently good condition.

June 1, 1926, while a search was being made in another locality for nymphs of another species, three fifth-instar nymphs of *Melampsalta calliope* (Walk.) were found. These presented one striking difference to those last observed in the cages. They all had bright red eyes. This suggested the possibility that time of emergence is foreshadowed by a change of color of the eyes of the nymphs. Accordingly, the cages of *Melampsalta calliope* (Walk.) were again examined. Not only did the nymphs called No. 8 have red eyes, but the eyes of all of those called No. 7 likewise had changed color. This indicated that all of the nymphs with large wing pads were the same age and would emerge during the summer. Consequently all cages containing these nymphs were covered with screen wire to prevent the escape of emerging nymphs. Most of these individuals had completed cells very close to the surface of the soil, but in no case did they appear to be resting or fasting.

July 16, 1926, two weeks after the last adult had emerged in captivity, two of the nymphs labeled Nos. 5 and 6 were found transformed to last-instar nymphs. When specimens are examined in midwinter and have been molted for a considerable time it appears impossible that these fourth-instar nymphs could become fifth instars with a single molt, but when they are observed just before and after molting the change seems simple. Before molting the abdomen becomes very much distended. Immediately after molting the new fifth-instar nymph is noticeably smaller than other specimens which have been in this stage for some months. The abdomen is slightly distended toward the center and all color markings are very delicate, some of the lighter parts appearing almost transparent. The cast skins of these two nymphs were found, one at the top of a vertical burrow about one and a half inches long and one at one end of a horizontal burrow about one inch in length. Neither of these skins gave any evidence of having been attached to the walls of the cell before being shed. Another nymph, which was carefully observed in the evening of July 16, molted during the night and was again observed on the morning of July 17. At both times the nymph appeared active and normal in every way.

A careful examination of all cages containing smaller nymphs failed to reveal a single specimen. The condition of the soil in some of these gave evidence that the nymphs had been eaten by ants or other predacious animals.

On November 19 the last cage, containing what had been called a No. 5 nymph, was examined and the nymph found to be a very small, delicately colored, fifth-instar nymph. The cast skin was found buried only a fraction of an inch beneath the end of the burrow. The appearance of the nymph and the position of the cast skin led to the conjecture that it had molted quite recently. If this conjecture is true, there was a variation of about four months in the time of molting of the fourth-instar individuals into fifth instar. This variation may have been increased by the abnormal conditions in the cages, but the size of specimens collected in the field tends to show considerable difference even in nature. Of the specimens in cages all of those with large wing pads either emerged as adults or died, and all of those grouped as Nos. 5 and 6 either died or changed to the last stadium. This evidence removed all question as to there being more than the normal five instars common to the Homoptera, and in the case of *Melampsalta calliope* (Walk.), seemed to give not longer than a year as the length of any one stadium.

Melampsalta calliope (Walk.) has not been reared from egg to adult in the laboratory, but sufficient data have been obtained on the length of the various stadia to warrant some conclusions. Nymphs which emerged in August, 1925, were in the third stadium in March, 1927. Since it is known that nymphs other than the first instar normally molt in the summer, and that first-instar nymphs of some of the other species molt in the fall after emerging in the summer, it seems safe to conclude that *Melampsalta calliope* (Walk.) nymphs molt from first to second in the fall after hatching, from second to third the following summer, and each succeeding stadium extends throughout a year. This would give *Melampsalta calliope* (Walk.) a total life history of approximately four years.

DESCRIPTION OF INSTARS.

FIRST INSTAR. Length, 2 mm.

Color of the body pink, appendages white. Antennæ seven-segmented, almost parallel sided, the outer segments forming a sort of club. Eyes red spots of pigment beneath the epithelium. Tarsi two-segmented with two apical claws of about equal length. (Pl. XXXVIII, Fig. 6.) Apex of tibiæ with several large spines, none of them with setæ. Apex of front tibiæ produced into a bifid tooth, with a small median tooth and large posterior one almost as long as the tibiæ with a smaller notch on its cutting margin. Body sparsely covered with stiff hairs. Length of front femora, .2 mm., of the pronotum .25 mm. (Pl. XXXIX, Fig. 2.)

SECOND INSTAR. Length of entire body, 3.29 mm.; length of front femora, 0.3 mm.; length of pronotum, 0.4 mm.

Color creamy white. Antennæ five-segmented, elbowed at apex of first segment; tapering from base to tip. Eyes small swellings on side of head with row of stiff hairs extending vertically across them. Tarsi one-segmented, scarcely discernible on the front legs. Tarsal claws mere stubs, the posterior one the longer. (Pl. XXXVIII, Fig. 6.) Apex of middle and hind tibiæ with two setæ-bearing spines. Front tibia prolonged into a claw-like projection with a tooth on the anterior margin. A flat, platelike shearing organ developed just anterior to the middle spine on the front femur (the comb), has two distinct teeth besides the large apical one. (Pl. XXXVIII, Fig 1.) This organ is termed "the comb" by Marlatt in his work on the seventeen-year cicada, and hereafter will be known by that name. The posterior spine with a tooth at the base. Wing pads not yet visible. In general shape this instar very closely resembles the third and fourth. (Pl. XXXIX, Fig. 3.)

THIRD INSTAR. Length of entire body, 6.5 mm.; length of front femora, 0.65 mm.; length of front wing pad, 0.3 mm.; length of hind wing pad, 0.2 mm.

Color creamy white, shading into fuscous on anterior half; cutting parts of front legs darker. Antennæ six-segmented, tapering from base to tip, elbowed at apex of first joint. Eyes inconspicuous swellings on sides of head with a row of stiff hairs extending vertically across them. Tarsi one-segmented, those of front legs scarcely discernible, middle and hind legs with two horny rudiments of tarsal claws, the anterior one the shorter. Apex of middle and hind tibiæ with two setæ-bearing spines. (Pl. XXXVIII, Fig. 6.) Front tibia with large notch near apex on cutting edge. Comb of front femur with three distinct teeth. (Pl. XXXVIII, Fig. 1.) Posterior tooth of femur bifid, distinctly built for digging. Wing pads barely discernible. (Pl. XXXIX, Fig. 4.)

FOURTH INSTAR. Length of entire body, 7-10 mm.; length of front femora, 1.2 mm.; length of front wing pad, 1 mm.; length of hind wing pad, 0.75 mm.

Color creamy white with cutting parts of front legs fuscous. Apex of middle and hind femur and apical end of some of antennal joints with brown bands. Antennæ seven-segmented, tapering from base to apex, elbowed at apex of first segment. Eyes inconspicuous with a row of stiff hairs extending vertically across them. Tarsi one-segmented; that of front leg hardly discernible, apparently without claws, those of the middle and hind legs bearing two horny projections, the outer the smaller. Apex of middle and hind tibiæ with two setæ-bearing spines. Front tibia clawlike with a blunt tooth well toward the tip. Comb of front femora with three distinct teeth besides the blunt apical one. (Pl. XXXVIII, Figs. 1 and 7.) Middle tooth of about same height as comb. (Pl. XXXIX, Fig. 5.)

FIFTH INSTAR. Length of entire body, 10-18 mm.; length of front femora, 1.8 mm.; length of front wing pad, 2.3 mm.; length of hind wing pad, 2 mm. The males tend to be slightly smaller than the females. General color runs from almost white to fairly dark brown. Posterior margin of tergites usually bordered with a darker band of brown, although in some specimens this is scarcely noticeable. Antennæ usually seven-segmented. Tarsi two-segmented, all distinct, the front ones turned back on the inside of tibia. (Pl. XXXVIII, Fig. 8.) Tarsal claws two, unequal in length, the outer much the shorter. Setæ-bearing spines at apex of middle and hind tibiæ, three in number. (Pl. XXXVIII, Fig. 6.) Eyes fairly prominent, becoming red just before emergence; posterior half sparsely covered with hairs. Comb of the front femur with five teeth, the largest one not much higher than the others. (Pl. XXXVIII, Fig. 1.) An indication only of a lateral tooth on tibia. General shape when compared with the fourth instar more cylindrical, with the three divisions of the body more nearly equal in diameter and their sides more nearly parallel. (Pl. XXXIX, Fig. 6.)

Proarna venosa (Uhler).

ADULT. *Proarna venosa* (Uhl.) is the smallest species which occurs in Kansas. In color it is gray with brown markings. Some specimens superficially resembled *Melampsalta calliope* (Walk.). It occurs practically throughout the state, but not in such great numbers as does the above species The habitat is a high dry hillside or hilltop, almost too barren to support vegetation. One cannot help but wonder sometimes what the adults feed upon and how the nymphs can exist in such rocky soil. In Scott county, Kansas, near the locality where *Melampsalta calliope* (Walk.) was taken in such numbers, *Proarna venosa* (Uhl.) was found in reasonable numbers about one-half way to the top of the hills which border Beaver creek. (Pl. XXIX, Fig. 1.) It was here that observations on feeding and egg laying were made, and that nymphs were collected.

BEHAVIOR. This species is a very sluggish insect, hardly moving from beneath the feet. It is usually discovered by sweeping the scanty vegetation. The song of the male is very shrill, but can be heard only a few feet, so it is not of much value in collecting. The greenish-gray appearance of the body gives the individuals excellent protection because of its resemblance to the color of the host plants. The most expeditious method of locating individuals for study in the field is to follow the specimens which fly ahead as the observer walks through the grass. This is readily accomplished, as they do not fly far. They feed frequently. Females have been observed trying to feed on the stems on which they were ovipositing.

OVIPOSITION. So tame is this species that it is a simple matter to make observations once a female is located. The following extract taken from the field notebook gives rather a vivid picture of her activities:

"June 24, found *Proarna venosa* (Uhl.) female at 8:15 a.m. At 8:26 she started ovipositing after moving around and finding a suitable stem of dead grass. The first nest was finished in seven minutes, or at 8:33, and another started immediately. The second was completed at 8:38, and the third begun immediately. This was finished at 8:48, and the fourth begun without delay—it being finished at 8:55. She then went around the stem one-fourth way and began the fifth at 8:56. She became startled at 8:59 and flew to a bunch of grass without any old stems. The stem in which she had been ovipositing was cut off and the end of it held down where she was clambering around in the blades of grass, and she immediately crawled upon it. She explored this a short time and then started to oviposit. Since the wind was so strong, the stem was carried over behind a cliff without disturbing the process. She was examined minutely with a hand lens, and held, with a notebook for a background, for a picture, seemingly without disturbing her in the least.

"In starting the nest, the body is curved to about a right angle and the ovipositor to somewhat less than a right angle, and a little foamy fluid is exuded on the stem. The ovipositor then begins to rotate in this spot of liquid with the saw-toothed valves working back and forth, first one and then the other. The teeth cut to shreds the tissue of the stem. When the ovipositor has been inserted full length the eggs are placed. Each egg can be plainly seen as it passes down the ovipositor. When the last egg has been laid the opening is filled with this same foamy material as was used at the beginning. She makes very little attempt to pat down the torn tissues of the stem, but moves almost immediately to a new place. This is practically one ovipositor length from the old one."

The eggs are laid in almost any dead plant stems that are at hand. In Scott county the dry fruiting stalks of a native prairie grass were favorite places.

NESTS. The nests are arranged in a single row lengthwise of the stem. From one to a dozen or more nests may be made in a series. The opening is very small and inconspicuous. Collecting them is facilitated by holding the grass stems in a loose bunch, and looking down into them. The observer detects the series of nests as white saw-teeth on the sides of the stems. Three or four small, white eggs are placed in a single row in a nest. They are 1.52 mm. long and .36 mm. wide. Unlike *Melampsalta calliope* (Walk.) these eggs remain white until hatching takes place.

In 1925 the eggs collected the week of June 24 showed red eyespots August 5, and postnatal molts were found about the nests August 10. The first nymphs hatched in the laboratory August 16, and hatching continued until September 27. Whether this relatively long hatching period was due to laboratory conditions or to differences in the time of oviposition, or whether it is a normal variation for *Proarna venosa* (Uhl.) has not been determined.

These eggs hatch the same as other species noted, and the nymphs are equally active and capable of building a home and finding food, but they are noticeably smaller than any other nymphs observed.

The first-instar nymphs transplanted in captivity appear to have died for want of food or to have been eaten by predacious enemies before molting. This total loss of considerable material is attributed largely to the unhealthy condition of the hosts used. At the time of this hatching, experiments were being conducted with some of the native western Kansas grasses, which did not thrive under insectary conditions. Also, surviving nymphs may have been destroyed by an attempt to find them in the soil, for it has since been admitted to be practically impossible to locate the first-instar nymphs in large quantities of earth.

Numerous excavations were made beneath bunches of grass which showed old oviposition marks without yielding any nymphs. This, in some measure, was due to the very rocky condition of the soil. However, by prolonged digging beneath and around yucca plants, about 30 were obtained. Three of these belonged to the third instar, 22 to the fourth and 11 to the fifth. No second-instar nymphs were found.

FIRST INSTAR. Length of entire body, 1.6 mm.; length of front femur, 0.2 mm.

Color of the body creamy white with the cutting parts of front legs darker. Antennæ usually six-segmented. Eyes red pigmented. Tarsi two-jointed with two tarsal claws, one much longer than the other. Middle and hind tibiæ with scattered heavy spines without setæ. Front tibia beaklike, with two teeth on the cutting margin. Front femur with a median sharp spine and a posterior one which is long and heavy with a tooth on the cutting surface. Body sparsely covered with stiff hairs. (Pl. XL, Fig. 2.)

SECOND INSTAR. This instar has not been seen.

THIRD INSTAR. Length of entire body, 6 mm.; length of front femora, 0.75 mm.; length of front wing pad, 0.4 mm.; length of hind wing pad, .3 mm.

Color creamy white, slightly darker on cutting parts of front legs. Body with a few scattered hairs. Antennæ usually eight-segmented, tapering from base to tip, elbowed at apex of first joint. Tarsi one-segmented, that of front leg indistinguishable on anterior margin of tibia, middle and hind tarsi with two apical claws of about equal length. Apex of middle and hind tibiæ with three setæ-bearing spines. Wing pads plainly seen as outpouchings of mesothorax and metathorax. Eyes represented by slight swellings on side of head with six small to large hairs scattered at random about its surface. Comb of front femora with three distinct teeth besides the blunt apical one. Ventral cutting edge of tibia with one notch. (Pl. XL, Fig. 3.)

FOURTH INSTAR. Length of entire body, 6.75 to 10 mm.; length of front femur, 1.25 mm.; length of front wing pad, 1 mm.; length of hind wing pad, 0 6 mm.

Color creamy white tinged with brown, margins of cutting parts of forelegs darkened. Antennæ usually eight-segmented, tapering from base to tip, elbowed at apex of first segment. Eyes less in evidence than in fifth instar, sparcely set with hairs. Tarsi one-segmented with two tarsal claws of almost equal length; that of the front legs very difficult to see with the naked eye, so closely appressed is it to the inside of the front tibia. Comb of the front femur with three well-defined teeth besides the blunt apical one; some show a very small fourth tooth. Front tibiæ with but one notch on ventral margin, apex of middle and hind tibiæ with three setæ-bearing spines. Each segment of abdomen with sparsely set row of hairs. (Pl. XL, Fig. 4.)

FIFTH INSTAR. Length of entire body, 16 mm.; length of front femur, 2.3 mm.; length of front wing pad, 4.2 mm.; length of hind wing pad, 2.2 mm. (Pl. XL, Fig. 5.)

Color creamy white with appendages and borders of body segments more or less tinged with brown. Antennæ usually nine-segmented, tapering from base to tip, elbowed at apex of first joint. Eyes fairly well developed, with a band of scattered hairs. Tarsi two-segmented, of normal size, with claws of unequal length. Apex of middle and hind tibiæ with three setæ-bearing spines.

This species differs from all others observed in not increasing the number of these spines with this molt. Front tibiæ with one tooth on ventral cutting side, middle tooth of femur large, considerably longer than the comb, a character which separates the nymphs of this species from those of *Melampsalta calliope* (Walk.). Comb with four well-defined teeth besides blunt apical one.

Cicada hieroglyphica Say.

ADULT. This is a rather small, green, black and straw-colored species, measuring 20 to 25 mm. in length. The colors of the body are so arranged as to blend almost perfectly with the lichen-covered trunks of the oak trees upon which they are found, making the individuals very difficult to find. The wings are held less rooflike than in our other species of cicadas, giving them a flattened appearance. The most striking character is the transparency of the abdomen when viewed with transmitted light.

DISTRIBUTION AND HABITAT. So far as is known this species is limited in distribution to blackjack (*Quercus marilandica*) and post oak (*Quercus stellatus*) groves in the southeastern corner of the state. Most of the data were obtained near the nursery of Mr. John Wilson, four and one-half miles southwest of Elk City, Kan. This nursery is located in some oak-covered hills, and made an ideal place to study a large brood which occurred there this past summer (1926). The only other locality where material was obtained was an oak grove twelve miles east of Columbus, Kan. This latter place was visited on June 6, 1926, when thirty nymphs of the three last instars were dug from the sandy soil beneath the oak trees.

No adults were present at this time. However, a few weeks later these woods were ringing with the songs of the males. While all other data obtained would lead to the conjecture that cicadas are not specific feeders, this species shows such a marked preference for the habitat described that one is forced to admit that if oak is not essential to life, at least it is greatly preferred. In both localities other trees surrounding the oak or between groves of it would yield no *Cicada hieroglyphica* Say.

Another element of interest in the habitat is the nature of the soil. In both localities studied the soil from which these cicadas emerge is almost pure sand. Whether it is the oak trees or the sandy soil they prefer so decidedly has not been determined; but the two habitats were so similar and the boundary so marked that it seems scarcely probable that it is merely coincident.

EMERGENCE. This species begins emerging about June 7, and specimens have been noted as late as August 7. They appear in greatest numbers about the first of July. The act of emergence has not been witnessed, but the appearance and position of the exuviæ and of the emergence holes leads one to conjecture that it is essentially the same as of other species of cicadas. The cast skins have been found in greatest numbers on the under sides of the leaves and branches of small oaks only two or three feet above the surface of the ground. This locality, near Elk City, is overgrown with these small oaks which come up everywhere from the roots of old stumps, making practically a solid mat of brush, so that it is difficult to observe the ground or to find the cast skins.

FEEDING. *Cicada hieroglyphica* Say in live cages fed frequently on oak twigs. No other host has been tried.

MATING. Matings have been observed both in the field and in live cages. Copula takes place as in all other species noted.

OVIPOSITION. So wary is this species, and so tiny and obscure are the nests, that much time was spent before any data were obtained on this phase of the life cycle. Although camp was pitched in the midst of oak timber which fairly rang with the songs of the males, and three days were spent, June 22 to 25, collecting and studying them both in the open and in cages, not a single nest was located. Fifty-one adults were confined in a mosquito-netting cage over live oak, but none of the females were seen to oviposit. It seems possible that this very flighty species may not oviposit in captivity as do many of the other species. It is considered, however, that this failure was due to the fact that the females were not yet fully matured.

A second attempt was made July 3 to obtain data on the oviposition. Even then the most diligent search by two collectors was not rewarded for several hours. Perhaps half a dozen females were spotted in the act of egg laying within the next day. The most cautious attempts to approach near enough to observe the process, however, resulted in disturbing them. It was noted that dead twigs were used exclusively for oviposition and the nests were found in the limbs from which the females had flown. It was then relatively easy, by diligent search along the small partially decayed twigs protruding from the main trunk of the tree to collect the limbs bearing the nests. These stubby limbs are characteristic of *Quercus marilandica*. (Pl. XXXIV, Fig. 2.) A goodly number of nests were found and brought into the laboratory for hatching.

NESTS. The nests are scattered at random on the twigs and are so small and carefully sealed shut that they often cannot be detected with the naked eye. In fact, nests have been cut into unexpectedly while the observer was dissecting a twig under the binocular. The decayed nature of the bark adds to the difficulty of finding the nests.

The eggs are invariably three in each nest, arranged in almost single file, with enough space between the last egg and the nest opening for another egg. The nest is filled with an excretion which appears, after drying, very much as empty broken eggshells might.

EGGS. The eggs, when laid, appear identical with all other cicada eggs observed. They are 1 6 mm. long and .4 mm. wide. In about seven weeks after they are deposited red eyespots appear, and a few days later the eggs hatch. The total incubation period is about two months.

The method of hatching and behavior of the nymphs is identical with that of other species described. The hatch appeared to be complete so far as observed. No parasites were reared from these nests. In fact, it would be difficult to prove that animals found in the limbs had been parasitic on the eggs of *Cicada hieroglyphica* Say, for the entire twig often reminded one of a tenement district. Nests of other species of cicadas, and evidences of innumerable other kinds of minute life were plentiful. The scarcity of the eggs was disappointing. About sixty nymphs were plated and perhaps a dozen preserved for study between September first and fifth.

NYMPHS. The nymphs hatched in the laboratory were transplanted to a small glass-sided cage which was well filled with orchard grass. This cage was buried in sand in the laboratory. October 10, 1926, an examination of part of the dirt in this cage revealed one nymph apparently not much larger than when hatched, but alive and active. It was returned to its cell and the remaining soil unmolested. Later the cage was buried with the other plate cages out of doors. This bit of evidence would lend encouragement to the hope that these nymphs will live on grass roots.

Other rearing experiments on nymphs of *Cicada hieroglyphica* Say are lacking. The nymphs in the field were so scattered and the labor of obtaining them so great that it seemed impractical to risk losing the material by attempting to keep it alive during the excessive heat and with the poor facilities at hand at the time. However, in the light of knowledge gained from rearing nymphs of other species, the examination of nymphs in the laboratory revealed a part of the story.

DIGGING FOR THE NYMPHS. Extensive digging was done on Mr. Wilson's place at Elk City, and perhaps 100 nymphs were found. The equipment for and technique of digging for nymphs were the same as used in collecting other species. The nymphs were found more frequently on the north side of very large trees as close to the trunk as it was practical to dig. They occurred usually from four to twelve inches beneath the surface. Few cells were seen because the soil was so sandy that the least disturbance would completely wreck them. The evidence obtained, however, indicates that they are not unlike those of other species.

Material could easily be sorted into five instars (four instars from the material dug, as the first-instar nymphs were not found). In addition, one could distinguish between the nymphs newly molted into the fifth instar and those which were soon to emerge as adults. Nymphs between these two extremes could not accurately be placed in either group. No attempt is made to estimate the length of time required for any one instar or for the total life cycle.

FIRST INSTAR. Length of entire body, 1.6 mm.; length of front femur, 0.26 mm.; length of pronotum, 0.28 mm.

Color creamy white, anterior half of body and legs amber. Antennæ usually six-segmented. (Pl. XLII, Fig 1.) First segment short and thick, second slightly longer than first, almost parallel-sided; third half as long as second; fourth slightly longer than third; fifth same length as third; sixth oval in shape, pointed at tip, a little longer than fourth. Eyes represented by small spots of black pigment beneath the surface. Tarsi two-segmented, tarsal claws two, long, slender, of unequal length, anterior one the shorter. (Pl. XLII, Fig. 2.) Tibia with three nonsetæ-bearing spines at apex. Front tibia produced into a sharp, clawlike organ with a sharp tooth on its cutting margin. Anterior femur without comb; middle tooth small, sharp; posterior one long, with a small notch on its cutting margin. Whole body sparsely set with stiff hairs. (Pl. XLI, Fig. 2.)

SECOND INSTAR. Length of entire body, 4 mm.; length of front femur, 0.5 mm.; length of pronotum, 0.6 mm.

Color of body creamy white, anterior half and legs darker. Eyes represented by swellings on side of head, covered on posterior half by hairs. Antennæ usually six-segmented (Pl. XLII, Fig. 1.), three apical segments and apical half of third somewhat inflated. Tarsi one-segmented, those of the front legs reduced to the merest rudiments, middle and hind legs with two tarsal claws of unequal length. Middle and hind tibiæ with three setæ-bearing spines (Pl. XLII, Fig. 2); front tibia beak-shaped, no teeth. Comb appears on the front femur with two distinct teeth on the cutting edge, posterior tooth large with no distinct tooth on its inner margin. Wing pads barely discernible. (Pl. XLI, Fig. 3.)

THIRD INSTAR. Length of entire body, 4.5 to 6.2 mm.; length of front femur, 1 mm.; length of front wing pad, 0.4 mm.; length of hind wing pad, 0.3 mm.

Color creamy white, shading into light brown on anterior half, cutting parts of front legs and apices of other legs. Eyes small swellings on side of head, posterior half sparsely covered with hairs. Antennæ usually seven-segmented (Pl. XLII, Fig. 1). Segments 4, 5, 6, 7 slightly inflated. Tarsi one-segmented, that of the front leg very small, two tarsal claws of unequal length. Middle and hind tibiæ with three setæ-bearing spines (Pl. XLII, Fig. 2), front tibia beak-shaped, with no teeth on inner margin. Comb of front femur with three teeth, besides blunt apical one (Pl. XXXVIII, Fig. 2); posterior tooth large with very small tooth near base. (Pl. XLI, Fig. 4.)

FOURTH INSTAR. Length of entire body, 7.3 to 11.5 mm.; length of front femur, 2 mm.; length of hind wing pad, 1 mm.; length of front wing pad, 1.5 mm ; length of pronotum, 2 mm.

Color creamy white shading to light brown on anterior parts; cutting parts of front legs and certain ventral sclerites fuscous. Eyes inconspicuous enlargments on side of head; hairy on posterior half. Antennæ usually eight-segmented, from third to tip tending to be inflated. (Pl. XLII, Fig. 1.) Tarsi one-segmented, exceedingly small on front legs. Apex of middle and hind tibiæ with three setæ-bearing spines. (Pl. XLII, Fig. 2.) Front tibiæ break-like; no teeth. Comb of front femur with four teeth (Pl. XXXVIII, Fig. 2), posterior tooth with small notch on inside. (Pl. XLI, Fig. 5.)

FIFTH INSTAR. Length of entire body, 12-20 mm.; length of front femur, 3.2 mm.; length of front wing pad, 6.5 mm.; length of hind wing pad, 3.6 mm.; length of pronotum, 4.3 mm.

Color creamy white, posterior borders of pronotum wing pads and abdominal segments fuscous. Cutting parts of front legs almost black. Antennæ usually eight-segmented; segments 4, 5 and 6 inflated (Pl. XLII, Fig. 1); fourth sometimes black. Postclypeus of peculiar rectangular shape. (Pl. XLI, Fig. 6.) Eyes large, projecting, posterior half sparsely covered with hairs. Tarsi two-segmented with two unequal apical claws. (Pl. XLII, Fig. 2.) Apex of middle and hind tibiæ with five setæ-bearing spines, front tibiæ beak-shaped with no spines or teeth on the cutting margin. Front tarsi bent back on inner margin of tibiæ. Comb of front femur with six well-developed teeth besides the blunt apical one. (Pl. XXXVIII, Fig. 2.) Middle tooth extends at a different angle; posterior tooth large, sharp, with an indication of a tooth on inner margin. Wing pads well developed. (Pl. XLI, Fig. 6.)

Tibicen aurifera (Say).

ADULT. *Tibicen aurifera* (Say) is one of the smaller species of this genus, measuring from 23 to 26 mm. in length. In color it ranges from green and black to almost orange and black. Freshly emerged specimens are often covered with long, golden-colored pile.

DISTRIBUTION. This species is found over the eastern third of the state, but not in definite broods any one year. It occurred over as large an area this past summer (1926) as it has for the past ten years. The special locality from which most of the data have been taken is a hillside one mile northwest of Midland, Kan.

HABITAT. *Tibicen aurifera* (Say) is most frequently found in small grass-covered areas containing shrubs. Often this habitat is near trees, and the males may be heard singing in them, too. While the largest number of nests taken have been in the hollow stems of panic grass (*Panicum virgatum*), they have also been found in other large grasses, in weeds, and in sumac (*Rus glabra* L.) which is a very common host. Where the latter is used, the nests are placed in the dead ends of twigs. The species is easily located by the song of the males. The adults are not wild, and hence are easily taken with the net. Although the male may be heard singing in trees, the female rarely oviposits in them. The individuals of this species are usually darker than their hosts and are comparatively easily seen.

EMERGENCE. The latter part of July *Tibicen aurifera* (Say) begins to emerge. It is, however, a late summer species, usually occurring in greatest numbers in September. Most of the observations on oviposition, etc., have been made during this month. In fact, it is among the last species to cease singing in the fall.

FEEDING AND MATING. The adults feed often in captivity, very much as any of the other species. Mating was observed on a compass plant (*Silphium laciniatum* L.) at Garnett, Kan., September 7, 1926. The individuals were end to end and remaining quiet during the making of a photograph. (Pl. XXXIV, Fig. 1.)

OVIPOSITION. (Pl. XXX, Fig. 3.) It was the finding of *Tibicen aurifera* (Say) ovipositing at the location northwest of Midland that first aroused my interest in the life histories of cicadas. The female seals the nest with an excretion, expending considerable time patting the torn tissue into place with the sheathes of the ovipositor.

NESTS. The nests are placed in a single row lengthwise of the stem. (Pl. XXXI, Figs. 1 and 4.) They are about the length of the ovipositor apart, and are separated by a little torn tissue. There may be from one to eighteen nests in a series. As has been stated above, the nest is neatly closed, leaving only a small mark on the stem. In grasses these nests are placed in the fruiting stalk. They do not injure the plant, in fact, they do not even weaken it materially. Normally the eggs are placed in two rows. Usually eight to twelve occur in a nest, but as many as twenty-two have been found.

EGGS. (Pl. XXXI, Fig. 3.) The eggs are 1.8 mm. long and 0.52 mm. wide. They remain white until hatched. Red eyespots appear during the second week in June, and hatching begins about June 16. This makes the egg stage at least nine months. Unlike most of the eggs which hatch the same season

Tibicen aurifera (Say) has a short hatching period. Within two weeks after the first nymph wriggles out, all have emerged. Practically every egg hatches which has not been parasitised, even to the occasional good egg in a nest where all others have been consumed.

PARASITES. Often as high as fifty per cent of the nests of this species are parasitized. A small metallic-green hymenopteron belonging to the genus *Syntomaspis* lays a single egg in the nest and the grub feeds on the eggs. (Pl. XXXI, Fig. 2.) Usually all the eggs in one nest are consumed by one grub, but occasionally in a large nest a few are uninjured. The grub obtains its growth and spends many weeks in a resting stage before pupating. In a few days after pupating, it emerges. In nature this emergence is timed nicely to coincide with the oviposition time of the cicada. In the laboratory the parasites have been known to emerge as early as May 7.

Some doubt has been expressed by hymenopterists as to the accuracy of the above data, but parasites have been observed in the field, and rearing has been done repeatedly under conditions which would allow no mistake as to identity. While the actual act of oviposition of the parasite in the field has not been observed, it is interesting to note that Fabre, writing in Souvenirs Entomologiques, page 272, recorded having observed a small hymenopterous parasite which he described as a chalcid 4-5 mm. long, black, with knotty antennæ increasing in size toward the end, and a long ovipositor situated toward the middle of the abdomen. He also states that in laying its eggs this impostor does not use the entrance to the nest made by the cicada but inserts its eggs through the solid wall of the stem and that the parasite subsists on the whole nest of a dozen cicada eggs. He did not collect the parasite, so could not learn its identity. He suggested that it might be new. More interesting still is the fact that Reaumur, writing in 1740, described virtually the same phenomena.

HATCHING. Just why it should have been difficult to learn to obtain the emerging nymphs cannot be explained unless because of so long an egg stage. Whatever the explanation, it must be admitted that bundles of stems containing eggs of this species and others were kept for months, only to let the nymphs emerge unobserved before the technique of obtaining them was perfected. The first success was in working with this species, and was somewhat of an accident. When red eyespots were observed the eggs were examined daily. On June 16 the stems containing the eggs were moistened because they had been kept dry for a few days while transferring from one laboratory to another. The stems had been left in the laboratory for a few minutes while further observations were made on a nest under the binocular. When the observer turned to remove the lot to the open again, they were found covered with many tiny, white nymphs. The wetting, together with the warmth of midday in June, had produced a large hatch. The chance circumstance gave the essentials of hatching eggs in the laboratory. Referring again to Fabre, one notes a similar experience. Having tried in vain repeatedly for two years to find the nymphs emerging, and finally, thoroughly discouraged, he laid a bundle of twigs on a chair, to be near his hand, and accidentally in front of his fire in the open hearth, while he made one last search in the twigs with his glass. When he turned to the chair to take up another twig, he found the nymphs emerging from the warmed nests by the hundreds.

NYMPHS. A year before any data had been obtained on the hatching of nymphs, a bundle of stems bearing *Tibicen aurifera* (Say) was placed over a large pot of *Panicum virgatum* and the eggs allowed to hatch naturally and the nymphs find their own way to food and shelter. Nothing was done to the sod for about eleven months, when the soil was removed by inverting the pot on a table and a search made for nymphs. By tearing about two-thirds of the root mass and soil into fine particles eleven nymphs were found. These were tiny white creatures 3 mm. in length which appeared to have many years to grow before they could emerge as adults. This proved beyond a reasonable doubt that *Tibicen aurifera* (Say) at least, had a relatively long life cycle. With *Magicicada septendecim* (Linn.) requiring seventeen years to complete its life and *Tibicen aurifera* (Say) giving evidence of requiring several years, little ground was left for belief in the popular statement, which so many authors had made, that the other species of cicadas probably develop in from one to two years. It was this information which caused the experiments to be started to obtain more suitable live cages, and some method of reducing the high mortality of nymphs during the first year.

Repeated efforts have been made to obtain nymphs in the field by digging on the hillside near Midland. A few nymphs have been obtained on many occasions. But since the first attempts at rearing nymphs were made with this species, it is not surprising that many were lost.

Observations were made, however, on the digging and feeding habits, and numerous hosts have proved satisfactory. Given sufficient food these nymphs form cells from an inch to two inches in length and large enough to allow freedom of motion of the legs. If the host thrives, they will remain in the same cell indefinitely, moving about very little. Even fifth-instar nymphs have been kept for months in cages little thicker than their cells. However, if the host dies, the nymph makes a heroic search for food. Third-instar nymphs have been observed to mine the dirt from end to end of a glass cage. A fifth-instar nymph, living in a large flower pot, was found to have tunneled the bottom half of the dirt thoroughly in search of food when the host had died. He was found in the bottom of the pot. When placed in a hole near live roots he simply completed his cell and remained for weeks where he had been placed. The only actual data on the length of the stadium that have been obtained is that the fifth requires more than one year for completion. The length of the first three stadia was determined approximately from the nymphs reared from eggs in the large pot referred to above. The first instar changes into the second sometime the first summer, the second into the third the second summer, and the third into the fourth the third summer. Thus, counting from the time the eggs were laid to the beginning of the fourth stadium, we have a period of three years. Definite data cannot be given as to the length of the fourth and fifth stadia at this time.

FIRST INSTAR. Length of the entire body, 1.8 mm.; length of front femur, 0.29 mm.; length of pronotum, 0.3 mm.

Color creamy white; digging parts of front legs fuscous. Antennæ usually seven-segmented, almost same size throughout. Eyes small, red granular pigmented. All tarsi two segmented with two tarsal claws of about equal length. Apex of middle and hind tibiæ with some large spines but no setæ;

apex of front tibia produced into a beak-like projection with two teeth on its anterior margin. Anterior femur with one small middle spine and a large, somewhat bifid posterior one. Body and appendages with the usual long, stiff hairs and spines. (Pl. XLIII, Fig. 1.)

SECOND INSTAR. Length of the entire body, 4 mm.; length of front femur, 0.5 mm.; length of pronotum, 0.6 mm.

Color creamy white to fuscous on cutting parts of front legs. Antennæ usually seven-segmented, tapering from base to tip; elbowed at apex of first segment. Eyes mere swellings on side of head, set on posterior half with sparse stiff hairs. Tarsi one-segmented; those of middle and hind legs with two claws, the anterior one slightly shorter; tarsi of front legs closely appressed to anterior surface of tibia, very small, scarcely discernible as such. Apex of middle and hind tibiæ with three setæ-bearing spines. Front tibia beaklike, bifid at tip and a slight sinuation at location of two small teeth in third instar. Comb of front femur with two distinct teeth besides blunt apical one, median tooth of about same height as comb; posterior tooth large, with a medium-sized tooth on its inner surface. Slight indication of wing pads. (Pl. XLIII, Fig. 2.)

THIRD INSTAR. Length of entire body, 7 mm.; length of front femora, 1 mm.; length of front wing pad, 1.2 mm.; length of hind wing pad, 0.3 mm.; length of pronotum, 1.2 mm.

Color creamy white, fuscous at apex of leg segments and cutting parts of front legs. Antennæ usually eight-segmented; outer two very closely joined. Eyes almost as in the second instar, slightly larger. Tarsi one-segmented; front one hardly distinguishable from side of tibia; middle and hind ones with two claws of almost equal length. Apex of middle and hind tibiæ with three setæ-bearing spines. Front tibia beaklike with three teeth—one large and two small ones. Comb of front femur with three distinct teeth, besides blunt apical one; middle tooth of about same height as comb; posterior tooth large, bifid. Wing pads discernible as small outpouchings of meso- and metanotum. (Pl. XLIII, Fig. 3.)

FOURTH INSTAR. Length of entire body, 8-15 mm.; length of front femur, 3.3 mm.; length of front wing pads, 2 mm.; length of hind wing pads, 1.5 mm.

General color creamy white turning to brownish on head, thorax and legs. Apices of leg segments, especially cutting parts of front legs, edged with black. Antennæ usually eight-segmented, smaller but of same general shape as that of fifth instar. Tarsi one-segmented, the middle and hind ones bearing two claws of unequal size; the front tarsi reduced to a small V-shaped segment with no sign of claws, so deeply embedded on the anterior side of the tibia that it can hardly be seen. Apex of middle and hind tibiæ with three setæ-bearing spines on anterior-ventral margin. Comb of front femora about as in fifth instar, but with only five main teeth. (Pl. XLIII, Fig. 4.)

FIFTH INSTAR. Length of entire body, about 20 mm.; length of front femur, 4.25 mm.; length of front wing pad, 7.75 mm.; length of hind wing pad, 5 mm.

General color brown with posterior borders of abdominal tergites, mesonotum and metanotum much darker. Apices of leg segments narrowly edged with black, also gonapophyses. Antennæ usually nine-segmented, segments parallel-sided growing smaller from base to tip. Apices of some segments may be edged with black. Tarsi all normal and two-segmented, bearing two claws, anterior one one-fourth the size of posterior, the latter slightly longer than the first tarsal segment. Tarsi of front legs well developed, turned back on anterior margin of tibia. Apex of middle and hind tibiæ with four setæ-bearing spines on anterior ventral margin. Front tibia bifid at apex. Comb of front femur with six teeth along its outer margin. (Pl. XLIII, Fig. 5.)

Tibicen vitripennis (Say).

ADULT. *Tibicen vitripennis* (Say) is colored much the same as *Tibicen aurifera* (Say) and is about the same size, with the exception that it is slightly more slender. The two species may be separated by the following characters: Uncus wishbone shaped, *vitripennis* (Say); uncus not wishbone shaped, *aurifera* (Say).

DISTRIBUTION. Roughly speaking, this species has been taken over the eastern half of the state. It occurs in greater numbers in the southern part than in the northern. No particular localities in Kansas have been under observation. The notes on oviposition and nests were obtained in the Arbuckle mountains in Oklahoma.

HABITAT. The habitat, unlike that of *Tibicen aurifera* (Say), is in trees and usually along streams. Willows and cottonwoods are favored hosts. The adults are usually located by the songs of the males, but as they are often high in the trees they are much more difficult to take than the species thus far considered. The songs of the males are quite distinctive, having as a part of it a series of clicks more like the song of some of the Orthoptera.

OVIPOSITION. It is large broods of this species which oviposit in cotton and corn, in some localities causing considerable damage to the crops concerned. William Newell, U. S. Dept. of Agri., Bureau of Ento. 60, p. 52-58, gives an account of a brood in Ouachita valley, La., where twenty per cent of the cotton plants were destroyed. Some fields were so badly damaged that they were plowed up. One man reported more or less damage for the past twenty years, but that year (1905) was the worst. The corn was preferred to cotton, the insects choosing the part of the stalk just beneath the tassel and placing so many nests in them that the tassel died without functioning. He counted three stalks with 297, 181 and 215 nests respectively. Each nest contained from 4 to 5 eggs. It was his opinion that each female laid about 1,000 eggs, and would oviposit in almost anything, trees, shrubs, fence posts, roof and walls of sheds. Even the hoe handles became so roughened by the oviposition of this insect, if they were left exposed during the noon hour, that they had to be smoothed with sandpaper. He also records one nest in a hollow weed with 75 eggs in it.

A recent number of the Quarterly State Plant Board Plant Bul. of Miss., vol. 6, July, 1916, No. 2, carries the following paragraph on this species:

> "A forty-acre field of cotton in Yunica county was severely injured by locusts or cicadas the latter part of June. The species responsible for the injury was *Tibicen vitripennis* (Say), which occurs throughout Mississippi, but is most abundant in the delta counties. The injury was caused by the females splitting the stalks and branches to deposit eggs, resulting in the death of the smaller stalks and the injured branches. About 90 per cent of the plants were injured and 25 per cent of the stand destroyed. Such heavy injury to cotton occurs very rarely. No control measures were used."

On July 17, 1925, nests of *Tibicen vitripennis* (Say) were collected in the cotton field of Mr. Sam Brown, four miles south of Davis, Okla., by the writer. The greater number of nests were found in the parts of the field nearest the timber which bordered the river. Only a small per cent of the stalks had been used as hosts, but in every case the placing of nests had resulted in the death of the plant above the nests. Usually the punctures had been made in the main part of the stem, although branches were sometimes used. Each nest was finished with a frothy excretion. The species had been heard singing in great numbers in practically every timbered section for miles around this locality.

NESTS. The nests were arranged in mismatched pairs, usually four or five pairs, only an ovipositor's length apart, then a little longer space before the next series began. In the stems sent to the laboratory there were from 13 to 37 nests in a stalk. The external appearance of the nest is not unlike that of *Melampsalta calliope* (Walk.). Perhaps they are a little less conspicuous from the fact that *Tibicen vitripennis* (Say) uses secretions in closing her nest. From three to seven eggs are placed in a nest, the number varying with the size of the stem used. They are 1.7 mm. long and 0.42 mm. wide, white in color when laid, turning to pink before hatching. *Tibicen vitripennis* (Say) occurs from June to August at least. No general statement as to the extreme times of egg laying or of hatching can be given. The eggs observed in the laboratory were laid before July 17. Red eyespots were observed in many of the eggs August 5 and hatching began August 7. These nymphs appeared to be hatching from one stem, while in other stems the eggs appeared very pink, and in still others the only pigmentation was the red eyespots. The hatch appeared to be complete August 15. The data are too meager to warrant conclusions, but if they are of any significance, would suggest a relatively short incubation period for the eggs. These stems were collected when only wilted and confined in a container for several days. When removed they were badly moulded, but the eggs were uninjured.

The newly hatched nymphs were placed in small glass cages in the open. September 20 two nymphs were found in a crab-grass cage, one still in the first stadium and the other in the act of molting. The first one was placed in a cage of orchard grass and was never seen again. The second one and its molted skin were preserved in alcohol. This specimen had a first stadium of six weeks. The total loss of this material was due, in part at least, to the experimental stage of rearing technique. No digging has been done for nymphs of *Tibicen vitripennis* (Say). An interesting question arises in connection with the nymphs hatching in cultivated fields. Do they all perish or are they, in nature, able to subsist on annuals?

Tibicen bifida (Davis).

ADULT. *Tibicen bifida* (Davis) is a brown and black cicada of medium size. A very striking character is the pruinose markings of the body, especially a dorso-median line extending the whole length of the insect. The opercula of the males are long and sharply pointed.

DISTRIBUTION. This species is confined to the western part of the state. The hills about Mr. Steele's ranch in Scott county fairly echoed with the songs of the males in 1925. Semidesert, prairie hills, with very little vegetation except sage brush and scattered yucca plants, form the habitat. (Pl. XXVIII, Fig. 1.) It makes its presence known by the piercing song of the males and can easily be traced down and collected with a net. The species is active during the heat of the day, but early in the morning and late in the afternoon it becomes sluggish, and is more easily taken. Although the females were observed ovipositing, and photographs were made, they could not be carried about while at work as could specimens of *Melampsalta* and *Proarna*.

EMERGENCE. *Tibicen bifida* (Davis) is classed as an early species. It is out in June and gone by the last of July or the first of August.

OVIPOSITION. Adults of this species have not been confined for observation, and the individuals are so wary that detailed study could not be made in the field. Females have been observed ovipositing in dead yucca stalks, and hundreds of nests so placed have been taken. (Pl. XXXIV, Fig. 4.) They are often arranged in rows which tend to wind around the stem to avoid branches. They may, however, be placed at random on the stalk. The nests are closed with secretions. One female spent ten minutes filling and closing a single nest, using care to pat the torn tissues into place before leaving to make a new one. The nests are not conspicuous, yet may be found readily if the stalk is examined. Dead yucca fruiting stalks, preferably more than a year old, are commonly used. Very rarely a few nests are placed in a green stem. Four eggs are placed in a nest, usually the first one alone in the bottom of the nest, the next two crowded very closely together and overlapping each other and the two end eggs, the fourth extending nearly to the opening. They are white when laid, and about the same size as those of *Tibicen aurifera* (Say). After red eyespots appear the entire egg becomes pink. Eggs laid before June 18 showed red eyespots August 3, and August 7 some of the eggs were pink, while others were still white. August 10 cast postnatal skins were found about the nest opening of some stems which had been out of doors, but no nymphs were hatched in the laboratory until September 13. The hatch appeared to be complete by September 27. These data give a range of six weeks from the time of the first hatching to the last. The variation is probably due to differences in time of oviposition. The egg stage appears to be approximately three months. Eggs collected in August of 1926 were not brought into the laboratory until the 24th of this month, and no evidence of eggs having hatched was observed. In three days, September 3-5 inclusive, 445 nymphs emerged from a large handful of stems.

In the summer of 1925 some newly emerged nymphs were put into small glass-sided cages, and others were allowed to hatch naturally over large pots in the open. Sixteen nymphs were placed in a small cage of *Panicum virgatum* on September 17. The grass had been transplanted in June and apparently started growing nicely. One of these formed a cell against the glass with a new, white root running through it, and remained there clearly visible through the glass for many days. By October 1 its abdomen was much distended. Later the grass died, however, and when food ceased the nymph dug out of sight. When the cage was opened, October 26, only two live specimens were found. These were transferred to another cage and disappeared.

Interesting observations were made of another nymph. When first observed it appeared to be feeling the sides of the cell with its antennæ and front claws. When it struck a root running through the cell, it clawed repeatedly, then appeared to insert its beak with difficulty. The middle and hind pairs of legs were raised to the back or sides of the cell, and the nymph gave every evidence of pushing. After inserting the beak, it remained very quiet for a considerable time feeding.

Others were placed in a cage of newly transplanted grass. When they were examined two or three weeks later they appeared no larger than when hatched. There was a marked difference in size between these and nymphs transplanted at the same time in cages of grass which had been growing. Nymphs appear to be unable to obtain nourishment from newly transplanted grass

Of those which hatched over pots in the garden little is known. No conjecture can be made as to the probable number which emerged. An examination of the soil in these was made May 27 of the next year. The first pot examined contained wheat, yucca and *Panicum virgatum* as hosts At this time the wheat had a nice root mass extending four to five inches in all directions, but at the time the nymphs entered the ground the roots must have been much fewer in number The yucca had only a few large, short roots. There is no evidence that one of these would not have furnished food for a nymph if it had had the good fortune to find it, but the per cent which would find them would certainly be very low. The panicum showed only a few sprays above the surface, but had formed a mass of roots both large and small on one side extending to and covering the bottom of the pot Just how much of this root mass was formed before the emergence of the nymphs it is impossible to say The search for nymphs was made chiefly on the sides of the pot where wheat and yucca had been growing, although it extended some into the panicum roots. One nymph was found at the bottom of the pot on the grass roots It was considerably enlarged, but had not molted Further examination was not made because of the danger of destroying individuals which might be overlooked. This nymph was placed in a small glass-sided cage. June 4 one claw was found in a run that some tiny brown ants had made in the cage Since the dirt was not all examined, and eggs were hatched over three large pots, it seems probable that data will yet be obtained from them. The information gained thus far indicates that at least some of the nymphs of *Tibicen bifida* (Davis) overwinter in the first stadium

The nymphs hatched in September, 1926, were placed in a large cage of *Panicum virgatum* which had been growing since May, 1926. During the hatching period this cage was left lying on its side. The top glass was removed and the nymphs allowed to fall on the dirt above the roots. When opened and examined on February 3, 1927, one second-instar *Tibicen bifida* (Davis) was found with its cell constructed against the glass. It seems probable that the more rapid development in this cage than in the pot described above was due to the food supply, although differences in hatching time might also have influenced the development.

Considerable digging has been done in the field in the hope of finding nymphs. Excavations were made about and beneath yucca plants whose fruiting stalks showed old oviposition marks, but only a very few nymphs were found in all the trials. These have the typical wrinkled appearance of a *Tibicen* and can be told readily from the nymphs of the other two genera occurring in this locality. An attempt was made to rear the material collected and it has either been lost through death of the individual or is still in the live cages.

Tibicen marginalis (Walk.).

ADULT. *Tibicen marginalis* (Walk.) is one of the largest of the Kansas cicadas. It measures from 36 to 39 mm. in length. In color the species is greenish and black or greenish yellow and black.

DISTRIBUTION AND HABITAT. This species occurs in the eastern third of the state. It is most commonly found in groves of willow or cottonwood along streams, although may be heard in other trees. A special study of this species has been made in a grove of birch on the farm of Mr. Wm. Payne, four miles northeast of Oswego, Kan., where large broods occurred in 1923 and 1926.

BEHAVIOR. The specimens are located by the continuous Z'we, Z'we, of the males. In the warmer parts of the day the adults are active and fairly difficult to take with a net unless the trees are low. The males are the most persistent and prolonged singers of any of the Kansas species. Their song begins as soon as the sun warms them in the morning and continues far into the night. Specimens have been heard as late as 1:30 o'clock in the morning. As the temperature is reduced with deepening night, the time of the song becomes slower. Just how long one male will sing continuously is not definitely known, but it is many times longer than for most of the other species.

EMERGENCE. Occasional specimens have been heard as early as June, and a lone male has usually sounded the last cicada note heard in the fall. In 1926 one was heard October 17. The largest numbers occur, however, in July and August.

MATING AND OVIPOSITION. Specimens have been observed in copula both in captivity and in nature. They remain either side by side or end to end. One pair mating in the top of a willow tree, perhaps twenty feet from the ground, was dislodged in an attempt to capture them. They fell striking the tree several times in their fall, but were not separated.

The female oviposits both in green and dead tissue and in a number of hosts. (Pl. XXXI, Fig. 7.) In Payne's pasture, in Cherokee county, birch is favored. Usually green twigs are chosen. These are often so cut by the ovipositor that they die. (Pl. XXXII, Fig. 1.) The corky bark of the trunks of willow is also used.

NESTS. The nests in green tissue are placed in one or two rows along the twigs, often slightly winding around the limb. If two rows are made the second nest is placed to one side and a little in advance of the first. Having filled the nest with eggs, the female forces the ovipositor deeply into the tissues just in front of the last egg thus raising the shreds up across the opening. She then exudes a secretion into the nest, which cements the improvised door in place.

EGGS. The eggs are pearly white, pointed at either end, 2.25 mm. in length and 0.5 mm. in width. The number of eggs in a nest varies from three to seventeen. The nature of the host used probably accounts, in part, at least, for the number of eggs placed in each nest.

Eggs collected in 1925 and kept suspended in the open until the following June showed red eyespots June 10, and hatching began June 15. A few nests of these were laid in birch in Cherokee county and collected August 13; the rest were taken in Douglas county. These were in willow. The hatch appeared to be complete July 8. These data would give a period of at least ten and a half months for the egg stage and a little over three weeks for the hatching period.

PARASITES. The eggs of *Tibicen marginalis* (Walk.) are sometimes parasitized by a small braconid which Mr. S. A. Rohwer, of the United States National Museum, has identified as a new species belonging to the genus *Heterospilus*. There is but one parasite to a nest of eggs. At maturity the grub rests in the otherwise empty nest throughout the winter. As the season for the appearance of the next brood of cicades approaches, the larvæ pupate and in a few days emerge as tiny reddish-brown braconids.

NYMPHS. Of the nymphs hatched in the laboratory, 51 were transferred to a small cage of orchard grass, 58 to another small cage, and 186 to a large cage of *Sorghastrum nutans*. During a part of the hatching period the stems containing nests were placed over a large pot of willow and cottonwood trees in the open. The nymphs in the small cages had all disappeared when examination was made October 10. This loss has been considered to be due to ants and other predacious enemies. One limb of birch, particularly well filled with eggs, was placed over a cage in the open for a few days during the hatch. When examined again many small, brown ants were found crawling about the dead stem. They did not appear to have molested the eggs in the nests. As there was nothing else to attract them, they evidently were capturing the nymphs as they emerged. Although such a condition left unchanged would have been disastrous to the nymphs from this series of nests, such a circumstance doubtless is exceedingly rare in nature because of the habit of the females of placing them so far from the ground and scattered about in relatively small series. An examination of the soil in the large cage February 3, 1927, showed three nymphs, one of the second instar and two of the third with cells built against the glass. These were not disturbed, and extensive examination was not made because of the fear of overlooking and thus injuring the tiny nymphs. The sod in the cage was removed from the locality northwest of Midland where *Tibicen aurifera* (Say) is found and might have contained two nymphs of this species, which would account for the two third-instar nymphs near the glass. Otherwise they must be *Tibicen marginalis* (Walk.), which have molted twice since hatching in June. They were quite small for this instar.

Large amounts of soil were examined in the birch grove referred to in an attempt to find the nymphs, but none was obtained. This was thought to be due to the immense number of trees in the locality compared to the number of cicadas. Excavations near a large, solitary cottonwood tree in a pasture in Cherokee county where *Tibicen marginalis* (Walk.) predominated, yielded four fifth-instar nymphs of a *Tibicen* which was thought to be *marginalis* (Walk.). These nymphs occurred in cells from four to twelve inches beneath the surface. Three of these were pickled for study, and the fourth was transported 150 miles in a mud cell to the laboratory. When placed in a large cage of willow it formed a new cell and appeared to be unharmed by the experience. Examinations of this cage February 3, 1927, revealed the nymph apparently in good condition in a large burrow near the bottom of the cage.

Tibicen dealbata (Davis).

ADULT. *Tibicen dealbata* (Davis) was first described as a mountain variety of *Tibicen marginalis* (Walk.), then later was made a separate species. It differs from this species in having a shorter distance between the eyes and in having greater numbers of pruinose markings.

DISTRIBUTION AND HABITAT. This species is found over the western two-thirds of the state. It practically always occurs in the trees along the watercourses, willow and cottonwood being preferred.

BEHAVIOR. While *Tibicen dealbata* (Davis) occurs west of *Tibicen marginalis* (Walk.), and its emergence time is a little shorter (perhaps due to higher altitude), no difference has yet been detected in the behavior of the two. The song sounds identical, the habits of singing are the same, the nests of one might be mistaken for those of the other, the same types of hosts are used, and the time and method of hatching and the appearance of the eggs and nymphs are identical.

EMERGENCE. Near Mr. Steele's ranch in western Kansas a fairly large brood emerged late in June and was practically all gone by the middle of August. It is known, however, that some individuals of this species are out as late as the first of September. While the adults have been collected and their song has been recorded in many localities throughout western Kansas and eastern Colorado, only this one location has been found which combined accessible habitat and a brood of sufficient size to make study feasible.

Along the north side of the ford across Beaver creek two miles north of Mr. Steele's ranch, in the southern edge of Logan county, a large brood of *Tibicen dealbata* (Davis) was found in June, 1925. These were emerging from the sandy soil under a thicket of small cottonwoods and willow near the creek. Their emergence holes showed very plainly, smooth and fairly round. The edges were flush with the surrounding surface. On June 22, when they were first observed, they were not singing and appeared to have emerged recently. On June 26 the males were singing, but no eggs were found. This locality was visited again August 13. Only a few adults were left, but the trees, especially the cottonwoods, were spotted with small patches of brown leaves. These dead leaves were due to the stunting of the twigs by the oviposition of the females. Small green twigs about the diameter of a lead pencil were chosen. The female, standing with her head toward the tip of the limb, makes a nest of about eight eggs placed in two rows, then moves a little to one side and out and repeats the process. (Pl. XXXI, Fig. 6.) When the eggs have been deposited, she forces her ovipositor deeply into the tissue in front of the nest and cements the shreds across the nest opening exactly as described for *Tibicen marginalis* (Walk.). (Pl. XXXIV, Fig. 3.) So close are her nests and so ragged the openings that the outer tissues of a limb may be in shreds for six inches and around half of its circumference. This type of oviposition often weakens the twig until the wind breaks it off. Even where not broken the twig may be sufficiently stunted to cause the loss of leaves, and may even die. Usually where larger twigs are used the limb is scarred, but no further damage is done.

EGGS. The eggs are pearly white, 2.25 mm. in length and 0.5 mm. in width. They are deposited throughout the summer months and hatch the next June.

The eggs collected in August, 1925, were suspended in trees in the open. On June 8, 1926, no eyespots were visible, but on June 10, when they were placed in trays in the laboratory, an extensive examination of many nests revealed that some of the eggs in all the nests showed the eyespots, but not all of them did June 13 nymphs began emerging Some of these nymphs were placed in small cages; 312 were placed in a large, glass-sided cage of *Sorghastrum nutans,* and 287 were placed in a similar cage with willow as their host All cages were buried in the open June 20 The nests were then suspended over a large pot of cottonwood in the open An examination June 29 showed the hatch practically complete Two nymphs emerged in a tray on that day. The above data gives an incubation period of at least ten months and a hatching period of sixteen days

NYMPHS An excellent opportunity to study the behavior of the nymphs was afforded by the small cages One nymph was observed feeding a few hours after emerging Unlike others observed, this one had its head bent back at a considerable angle, and the beak was still practically straight This observation offered the suggestion that perhaps the beak at first is bent slowly, and even with some effort When it is completely bent, however, it remains always so No nymph has been observed, after the first day or two in the soil, which did not have its beak placed almost at a right angle to the body The nymphs in the small cages appeared to thrive until placed in the open When examined October 10, however, no trace was found of any of them

The large cages were examined February 8, 1927 The willow trees had died leaving all the 287 nymphs to die The grass, however, was in good condition No nymphs were seen against the glass as were observed in the case of *Tibicen marginalis* (Walk) and *Tibicen bifida* (Davis), and an extensive search was not made because of the danger of injuring those that might have survived

Attempts to secure nymphs by digging in the Logan county locality were made on two occasions Each time a few were found, but the series is still incomplete In August, 1926, several nymphs were transported in mud cells by automobile to the laboratory Two days' delay in transit necessitated the nymphs being so confined for three days When removed, they all appeared dead They were placed in an empty tray which was covered with a damp cloth and left over night In the morning several of the nymphs were crawling about Two fourth- and fifth-instar nymphs thus revived were transferred to artificial cells with roots running through them in a large cage containing willow Six days later well formed cells could be seen where three of these had been placed These were again examined Febraury 4, 1927, and found to be in good condition

Tibicen dorsata (Say).

ADULTS *Tibicen dorsata* (Say) is a large brown and black cicada with very conspicuous white pruinose spots It is close to *Tibicen marginalis* (Walk) and *Tibicen dealbata* (Davis) as to size, but may be separated from them by having the fore wings with cross veins between R_3 and R_{4+5} and between the latter and M_1, distinctly darkened

DISTRIBUTION AND HABITAT. This is one of the commonest Kansas cicadas and occurs in all parts of the state Unlike *Tibicen pruinosa* (Say), it does not prefer trees, and therefore is not so common about the cities and towns It is a lover of the wide open places, and, although it does not disdain to rest in a tree if there are trees about, it much prefers the open fields, even cultivated ones, and prairie land. It is very noticeable, in localities where this species occurs with *Tibicen dealbata* (Davis), that it is to be found out in the open perched on a briar, or even grass stems, perhaps not a foot above the ground, while *dealbata* will almost always be found in the larger trees of that locality.

BEHAVIOR. The adults are easily located by the songs of the males. During the heat of the day, especially at the first of the season, the species is wild. All the cunning of a wild-game hunter is required, and then one must be quick to strike and sure of aim to take them. This species, when it has been struck at with a net and missed, has the habit of flying up an angle of about 45 degrees and going usually out of sight. If perchance the specimen does not go out of range of the eye, it will appear to fall almost straight down when coming to earth and will alight immediately.

The song of the male is coarse and loud but not prolonged. As has already been stated, it sounds not unlike the distant hum of a mowing machine or certain type of tractor. Not a few females have been collected from the cab of a Fordson tractor while plowing. The females would fly about the engine and finally alight on it as it moved along. This species occurs so generally that it is difficult to find it plentiful enough to get much data. To render nymphs available by digging, a species must be localized in large numbers, and such a brood of *Tibicen dorsata* (Say) so far has not been found.

EMERGENCE. This species appears in June and is pretty well gone by September, although occasional specimens are found throughout this month. Perhaps the purest and one of the largest broods was studied in July, 1925, near St. Francis, Kan. Adults were out in large numbers July 3 in a large pasture covered with sagebrush. August 23 the adults were gone entirely. A bundle of stems of sagebrush bearing nests was collected at this time. Although the brood had disappeared so early in this locality in the extreme western part of the state, specimens were observed in eastern Kansas the same year until September 10, and in 1926 they were kept alive in outdoor cages until September 30.

FEEDING. When furnished with the proper food this species will live, apparently happy, for several weeks in captivity, whereas, if confined without food the specimens die in a short time. Adults begin to feed within a few seconds after being placed in a live cage, and have been observed to feed frequently throughout confinement.

MATING. Matings were observed both in captivity and in the field. It is as has been described in other species. They may be end to end or side by side. Probably the latter is the normal way, and it is only by being disturbed that they change.

OVIPOSITION. (Pl. XXXI, Fig. 5.) The female oviposits in anything that is at hand. Green tissue or dead is used without preference. Nests collected near St. Francis, Kan., from sage brush were mostly placed in dead stems. Large numbers of nests were also made in captivity. Perhaps most of these were in green tissue, although dead twigs were provided so the females could have their choice. The nests in green material resembles those of *Tibicen marginalis* (Walk.) as to arrangement and appearance. In dead material they may be scattered about or in single rows. This is governed somewhat by the size of the material used. If it is a large stem the nests may be scattered, while if it is a small twig they are usually in a single row.

The number of eggs in each nest varies according to the kind of material in which the nests are placed. In soft material, either dead or green, the number varies from twelve to fifteen to the nest, while in hard wood the number varies from three to five, with a preference for three. After the last egg is laid the female cuts a few shreds of material from the limb by inserting the ovipositor at the end of the last egg, and cements them in place, thus very effectually closing the nest. This is done in either dead or green tissue.

EGGS. The eggs are spindle shaped, a little more pointed at one end than at the other. These, as other cicada eggs, are often distorted in shape to conform to the chamber in which they are placed. They measure 2.75 mm. in length and 0.5 mm. in width, and are pearly white in color.

The eggs collected in August, 1925, were suspended in the open until June, 1926. June 10, red eyespots appeared, and June 12 an examination revealed some empty shells. June 13 the first nymphs emerged in the laboratory. The hatch appeared to be complete by June 29. This indicates that *Tibicen dorsata* (Say) has an egg stage of about ten months and a hatching period of a little over two weeks.

Fifty-two of the newly emerged nymphs were placed in small glass cages and seventy-seven were transferred to a large cage of *Sorghastrum nutans*. As with the other small cages of newly emerged nymphs, so *Tibicen dorsata* (Say) nymphs disappeared completely in a few weeks after having been placed in the open. The large cages were examined superficially February 3, 1927. The grass was in good condition. No nymphs were observed, but extensive search was not made through the soil.

Extensive excavations in the sagebrush locality failed to reveal a single nymph. Cast skins could be found on the ground about the bushes, and old ovipositor marks were located, but the nymphs were apparently so evenly distributed over so large a territory that they could not be located with a reasonable amount of work. The sandy nature of the soil would render the tiny nymphs almost indistinguishable, thus adding to the difficulty of finding them.

Better success was enjoyed in a sumac thicket in a pasture on Mr. Al Smith's place, three miles west of Lawrence, Kan. *Tibicen dorsata* (Say) adults had been taken there in sufficient numbers to suggest the possibility of finding the nymphs. Excavations near old shrubs yielded a fair number of individuals on the first attempt. Occurring with these, however, were nymphs of *Tibicen aurifera* (Say). The fifth-instar nymphs could readily be distinguished, but the smaller ones required more study. Some of these nymphs were preserved for laboratory work, and others were transplanted in small glass cages. When a second attempt was made to collect material it was discovered that sheep had eaten the sumacs and other shrubs so completely that it was impossible to recognize where the first digging had been done. This attempt yielded very little material. Thus, while it has been demonstrated that the nymphs feed on perennial roots in cells from three inches to twelve inches beneath the surface, and that they will live on grass roots in small cages, no data have been obtained on the probable length of the life cycle. The series of nymphs is not complete. They do add their bit of proof to the supposition that the nymphs of the different species within a genus are confusingly alike. This is not surprising when one considers that many of the adults are classified by size and color, characteristics which are not satisfactory with the nymphs.

Tibicen pruinosa (Say).

ADULT. While *Tibicen pruinosa* (Say) is perhaps the best known cicada in Kansas, little information has yet been gathered on its life history. It occurs every year through several months in almost every grove in the state. Especially does it predominate in cities and towns. Even in a locality where other species, such as *Cicada hieroglyhica* Say or *Tibicen marginalis* (Walk.), have been found in large broods in the woods surrounding the towns, the lazy "Za-wie, Za-wie" of *Tibicen pruinosa* (Say) is the song that lulls the inhabitants of the city to peaceful reverie or irritates them to murderous thoughts, according to the particular disposition of the listener. The nearest approach to a brood of this species which has yet been observed was found in September, 1926, in an apple orchard near Waverly, Kan. No opportunity was offered, however, for an extensive study of this brood. Adults have been collected in Cherokee county and in Douglas county and their behavior studied in live cages. (Pl. XXXIV, Fig. 5.)

HABITAT. As has been suggested, it is essentially a tree-loving species, and the adults are located by the singing of the males. Live specimens are collected by means of the long-handled net referred to previously. The females are located by scanning the surfaces of the limbs and trunks of the trees. They are so nearly the color of the host that some practice is necessary to enable one to see a very large per cent of those actually present. If the trees are small and the grove not too dense, specimens which escape may often be followed to their new position. In groves of large trees they have a disheartening tendency to fly to a higher perch when disturbed.

EMERGENCE. The largest numbers emerge at night, although it is not uncommon to find nymphs crawling about in the daytime in search of a desirable spot for transformation, or to find specimens in some stage of this process during the day. Often one is found which has been fatally injured but is still alive and soft, showing that its emergence had been started in the daytime.

On August 29, 1926, about a quart of cast skins were collected near the sidewalk along a half dozen city blocks with the idea of obtaining any information these might offer. Some of them were on the ground at the base of the trees, others were on grass blades or weeds near the base, a much larger number, however, had found the trunks of the trees and crawled up. Skins could be seen 20 feet from the ground. No data have been obtained as to how high some had gone.

At 5 p.m. a nymph was found about five feet from the ground, crawling slowly up the trunk of an elm tree. It was removed to the arm of the collector where it continued its crawling while the observer walked two blocks. It crawled in an upward direction. At the laboratory it was removed to an elm limb an inch and a half in diameter and two and a half feet long. When moved from one place to another with the hands it immediately resumed its climbing upon being released. When it reached the top of the limb the limb was inverted, and it turned around and began ascending it immediately. About halfway to the top it stopped and carefully lifted and placed each pair of legs on the bark. No estimate could be made as to how far the emergence hole was from the base of the tree where it was found, but it was estimated that the nymph had crawled about twelve feet after reaching it, and had spent over one-half hour doing so. Having placed its legs satisfactorily, the claws of the middle pair firmly imbedded in the bark, the nymph rubbed its face and antennæ repeatedly with its front claws. Then it stood quite still for a moment and again rubbed the front legs carefully over the head. It finally came to rest with the front claws suspended in the air. At 5:50 the skin burst slowly in a dorso-median line the length of the mesothorax. In three minutes the slit extended to the frontal suture, whence it quickly opened crosswise to the antennæ, at the same time extending backward to the first abdominal segment. During this splitting of the skin no motion could be detected, but upon its completion a rolling motion within the body began. By 5:55 the body was bulging visibly through the opening. Four minutes later slight quivers were noticed in the mesothorax every few seconds. By 6 the head had slipped clear of the skin and the quiverings were more frequent. At 6:02 the first segment of the front legs was clear of the skin and the crumpled wings were emerging. At 6:05 the second joint of the front legs had appeared and only the tips of the wings were holding in the skin. The wings were very light green, orange and white mottled. At 6:08 the wings were free and the legs practically so. At 6:09 the wings were held horizontal to the body. The body was extended at right angles to the shell, ventral side up. The body quivered again two or three times. At 6:11 it folded its tarsi a little. By 6:13 the abdomen was still holding but the feet were all free, and the mouth parts, which had been separated, all came together again in a normal position. At 6:14 the wings were expanding slightly; the hairs on the tibia had become black; the tarsi were orange and the remaining portions of the legs green. At 6:18 the wings appeared mostly light green, the body bent down from the horizontal at about a 60-degree angle. At 6:23 the hind pair of legs moved a little and came to rest at right angles to the body. At 6:28 it raised the body up, caught hold of the exuvium with all legs, and began to move the wings, which were enlarging rapidly. At 6:29 the abdomen was freed from the now empty shell. The genitalia (male) were protruding out and back. The wings were nearly one inch long, with the veins green. At 6:33 the left wing was enlarged noticeably more than the right. This was thought to be due possibly to the current of air on the left side caused by the explosion of flash-light powder. The wings were milkly to clear. At 6:38 it moved to the left side of the shell and off on to the limb. The wings were nearly full length, the genitalia still protruding. At 6:42 it moved the legs a little; at 6:48 the wings were much clearer but still held flat, the veins light green. At 8:50 the cicada had crawled to the top of the limb. The wings were held rooflike, the color markings pale, the body soft, the genitalia not entirely retracted. The following morning the cicada appeared a normal, mature male. He was placed in a live cage where he was later observed singing and feeding.

The above is the only emergence which has been observed in such detail and timed as closely, but it is considered to be essentially characteristic of the various species. In all cases it appears to be the claws of the middle pairs of legs which hold the cicada while emergence if effected. The front pair of legs are left free to assist in freeing the loosening skin from the delicate structure of the anterior part of the body.

Tibicen pruinosa (Say), like those already described, feeds on any convenient host at all hours of the day.

Numerous matings were observed in captivity. The process requires from a few minutes to one and a half hours. More than one male may mate with the same female. It was interesting to note that the variety *fulva* Beamer, which has been found in Cherokee county only, intermates with *Tibicen pruinosa* (Say) without discrimination. Dark males with light females, dark females with light males, light males and females, and dark males and females have all been observed mating in the same cage. Other males in a cage become greatly excited and sing lustily when a pair is in copula.

OVIPOSITION. In most of the cases of oviposition which have been observed in the field the female was using the corky bark of the trunks or the large limbs of live trees. In cages where the live host is small green twigs oviposition has always been in dead limbs placed in the cage for that purpose. No nests have been found in small green limbs. They are placed at random. The external appearance is similar to the hole made by inserting a pin into the bark. Observations would tend to show a preference of the females in nature for relatively low positions on the trunks of large trees. Very often nests are placed no higher than on a level with one's eyes. The females can often be observed at short range in the field, although they are more wary than some of the smaller species.

Tibicen auletes (Germar).

ADULT. *Tibicen auletes* (Germar) is the largest species of cicada known to occur in Kansas. It measures 40-42 mm. in length. In color it is greenish brown and black. Newly emerged specimens are almost entirely covered with pruinosity.

DISTRIBUTION AND HABITAT. This species occurs practically all over eastern Kansas. It is, as a rule, not an abundant species. A male may be heard singing almost any day, but very rarely does one hear many. A rocky draw running east from Lyons creek just east of Woodbine, Kan., is the only locality where a brood has been located. There, in 1923, a large brood of this species was found. This locality has been visited each year since in the hope of obtaining data on the length of the life history of this species. In 1924 there appeared to be almost as many specimens out as in 1923, but none were found in 1925, and only an occasional one in 1926.

Tibicen auletes (Germar) is easily detected by the song of the male which, at least in this region, is loud and harsh. The song begins slowly, gradually increasing to a crescendo and then subsides. It is represented by the following: T - T - T - T-T-T-d-d-d-d-d-d-d-T-T-T. The T is repeated slowly and the d quite rapidly with a crescendo in the middle. The noise is fairly deafening during the hours when a large brood sings. Greater numbers sing from 9 to 11 a. m. and from 2 to 5 p. m.

Rocky ravines and hillsides covered with oak trees, *Quercus stellata*, etc., are preferred habitats. The adults are not unusually wild, and if the trees are short the specimens may be taken easily with a net.

OVIPOSITION. The females, in all cases observed, were ovipositing in the dead limbs of the oak trees which they frequent. The limbs used were about three-quarters of an inch in diameter and had been dead for some time. The nests are not placed in any regular manner. They were usually on the under surface of the twig and very hard to locate if the female was not present, as the opening appears about as any other abrasion of dead bark. Oviposition occurs in August and September.

No rearings have been attempted on this species. Material has been too scarce the past two years to secure eggs and thus begin rearings, and the habitat in which this species delights is so rocky that digging for nymphs in the field is practically impossible.

Tibicen chloromera (Walk.).

ADULT. *Tibicen chloromera* (Walk.) is a medium-sized cicada, almost black in color. It may be separated from *Tibicen lyricen* (DeGeer), which it closely resembles, by its very long opercula and by the white color of the venter.

DISTRIBUTION AND HABITAT. This species is confined to the southeastern portion of the state, having been collected in various parts of Cherokee county, but studied in detail only in a birch thicket about four miles northwest of Hallowell, on the farm of Mr. Wm. Payne. Here a large brood was observed in 1923, and many specimens were taken. Comparatively few individuals occurred in 1924 and 1925, but in the summer of 1926 another large brood occurred. This locality was visited August 26, and again the second week in September. In the early morning the woods rang with their song, but by 10 o'clock it had subsided, and throughout the remainder of the day only an occasional individual was heard. One might have spent considerable time in the woods in the afternoon without being aware of the presence of this species, although males of *Tibicen marginalis* (Walk.) and *Tibicen pruinosa* (Say) sang in great numbers throughout the day.

A few specimens of this species have been heard singing in July, but the greatest numbers occur from the latter part of August till the middle of September. Males confined in cages sing, but not as frequently and persistently as those of the other species studied at the same time.

FEEDING. Adults have been observed feeding on birch, maple and apple, all hosts on which specimens have been caged. They feed freely and often, as do the other species.

MATING. Matings were observed frequently in captivity. A pair remains in copula for from one-half hour to over an hour. Several specimens were confined for several hours in a large pasteboard box with specimens of other species during their transportation from Cherokee county to Lawrence, Kan. When they were removed to live cages after the trip, a female *Tibicen chloromera* (Walk.) was found in copula with a male *Tibicen pruinosa* (Say).

OVIPOSITION. One female was observed in the open making a nest in a green birch limb less than one-half inch in diameter. She made one nest and sealed it carefully with a secretion, then began another nest, when a careless motion frightened her away. She allowed the observers to bend the limb on which she was working several feet nearer the ground and to watch her at a distance of perhaps four feet for several minutes. Another female observed in nature was ovipositing in dead willow. She, too, was relatively gentle, allowing the observers to approach to within a few feet of her. Several pairs were confined in live cages over birch, maple and apple. In cages the females used dead tissue exclusively for nidification. In all cases the nests were closed with secretion.

The nests are placed irregularly. From the meager data obtained one would infer that the females do not lay as many eggs as in many other species; or at least, if they do, that they scatter their nests far apart and oviposit over relatively long periods of time. Very little external evidence is left when the nest is completed. The external opening is entirely filled with a gluelike substance appearing externally much as a bit of the gum which exudes from a wound in a cherry or peach tree. Specimens of this species confined the same length of time as other species laid far fewer nests.

From nine to eleven eggs are placed in a nest. They are arranged in two rows similar to those of *Tibicen aurifera* (Say), etc. (Pl. XXXI, Fig. 3.) The nests are very close to the surface of the twig, and the last egg in a great many cases extends almost flush with the bark. (Pl. XXXVIII, Fig. 5.)

The eggs are 2.33 mm. in length and about 0.5 mm. in width. They are white and of the same general shape as other cicada eggs. None have been hatched in the laboratory.

Tibicen lyricen (DeGeer).

ADULT. *Tibicen lyricen* (DeGeer) is a medium-sized cicada, black in general color with some brown markings. It resembles very closely *Tibicen chloromera* (Walk.), from which it may be easily recognized by the smaller and more sharply pointed opercula.

DISTRIBUTION. This species seems to be fairly well distributed over the eastern half of the state. Only occasionally does it occur in fairly large broods in any one locality It is usually represented by a few specimens in almost all woodland.

HABITAT AND BEHAVIOR. This species is fond of trees, the larger the better. It is only where the forests are low that one may take the species easily with a net. The adults are readily located by the songs of the males. These are of short duration and characteristic of the species. They resemble somewhat those of *Tibicen chloromera* (Walk.) but do not have the crescendo of the latter species.

EMERGENCE. *Tibicen lyricen* (DeGeer) has been collected from July 13 to September 18. The greatest numbers occur in August. One locality about five miles south of Garnett, Kan., where a large brood of this species appeared in 1923, has been under observation each year since. This place is a north slope too poor to support but a very meager vegetation. Persimmon trees growing there are not much over the height of an ordinary man; and other vegetation in proportion. This made an ideal location to observe the adults, and it was here that the females were observed in oviposition. Small dead persimmon twigs were chosen, smaller than a lead pencil. When the nest was completed the opening was filled with secretion and the torn shreds of the host so well replaced that it was next to impossible to find the nest after the female had gone.

OVIPOSITION AND NESTS. The nests occur singly scattered over the twigs. They may be placed either in dead or live tissue. As was published in Annals of Ent. Soc. of Am., Vol. XVIII, pp. 479-482, the nests differ from other species in that one, two or three nests may be made from one external opening. The nests may all be in the same general plane, radiating from a common center, or one may be below the others.

EGGS. There are from six to twelve eggs in a nest, placed in the regular order and of about the regular size. No data have been secured recently on this species, as it has not appeared in large numbers the past two seasons, and attempts to dig for nymphs have resulted in failure.

Tibicen linnei (S. & G.).

ADULTS. *Tibicen linnei* (S. & G.) resembles *Tibicen pruinosa* (Say) very closely in general appearance, but the songs are markedly different. The former is reputed to have a bend in the costal margin of the front wing, while the latter has the costal margin an even curve. In reality specimens collected and confined in live cages have shown the inaccuracy of separating them by these characters alone. After a careful study of many specimens of both these species the shape of the posterior end of the opercula seems the only infallible character. (Pl. XXX, Figs. 4, 5.) This is a character which is easily seen, and proved constant for a great many specimens which had been killed while singing.

DISTRIBUTION AND HABITAT. This species occurs only in the northeastern third of state. It lives in trees, the same as *Tibicen pruinosa* (Say), and in this section is to be found closely associated with it.

BEHAVIOR. The males are located by the song. This sounds much as a few bits of glass would if rattled in a tin box. The males have been observed to crawl nervously about during the song, either backward or forward but not going far in either direction.

EMERGENCE. No large broods have been observed. During the fall of 1926 many hours were spent collecting live adults of both *Tibicen linnei* and *pruinosa,* for it was impossible to tell them apart even after they were taken. At this time a study of the distinguishing characters had not been made. Attempts to separate the two species by the curve of the wing resulted in failure. Several specimens were isolated by this character for *Tibicen linnei* (S. & G.) only to have the males, in practically every case, sing out in the approved song of *Tibicen pruinosa* (Say). Specimens of *Tibicen linnei* were obtained, but in no case where oviposition was obtained of isolated specimens did this individual prove to be the desired one. Hope was held that if males could be located by their song and placed in live cages with females of the two species their mating would identify the females. However, since individuals of different species have been known to mate, this does not offer an infallible proof. While *Tibicen linnei* was heard singing almost daily for several weeks during the summer and fall of 1926, it did not occur in sufficient numbers to make extensive study easy. Almost invariably the males which were singing could be traced to a perch high above the reach of the longest net, and attempts to climb for them resulted in frightening away the cicada, which flew high and far out of sight.

Magicicada septendecim (Linn.).

Magicicada septendecim (Linn.) is not mentioned here with the hope or thought of adding anything new to its life history. It being the one species whose life history has been recorded, has been used as a control. A brood has not emerged in Kansas since the present work was started, and hence no comparison from first-hand data can be made on the adult behavior, the egg, or first nymphal stages of the species with the others studied.

A locality covered with locust trees was found west and south of Lawrence on the Wakarusa river where Dr. H. B. Hungerford had collected this species in quantities in 1911. Digging in this locality yielded nymphs in unsuspected numbers and gave an excellent opportunity for the study of nymphal behavior in nature, and also gave abundant material for laboratory experiments. It is to be regretted that this rich field was not located sooner, so that the first experiments with cages and hosts might have been conducted with them. With such experimentation much of the valuable material which was lost might have been saved.

Only two broods of this species are recorded for Kansas each seventeen years. These belong to Marlatt's broods Nos. 1 and 4. Brood No. 1 will emerge in 1928, and brood No. 4 in 1930. Both broods were represented in the material dug in this locality. Individuals of brood No. 1 were in the fifth stadium and were perhaps ten times as numerous as those of brood No. 4, which were in the fourth stadium. Considerable difference was noted in the size of the individuals within the stadium. Some appeared just to have molted, others appeared to be mature. How much variation there may be in nymphs which will emerge the same season cannot be given at this time. Considering the probable presence of the variety *cassinii* (Fish.) with the seventeen-year, one would expect considerable difference in the nymphs. However, some observations have been made which show there are different aged specimens present.

Early in the spring of 1926 many nymphs were preserved and several of both instars were placed in live cages. In June an adult was heard singing in the trees near the laboratory, and a careful study was made of the locality where digging had been done. Occasional emergence holes were observed; a dozen skins could have been collected without difficulty; a male specimen of *cassinii* (Fish.) was taken alive, still soft, and an occasional male could be heard in the trees. There were too few, however, to obtain much data on them. The male taken alive lived for two weeks and sang daily in a cage over cherry. A number of other specimens were taken in various localities scattered over southeastern Kansas this same spring, and numerous others were heard singing. Of the nymphs in live cages a large per cent of them lived, feeding on grass roots, even though the cage was little thicker than the cell. Two of the fourth-instar nymphs molted into fifth in captivity while the others remained in the fourth stadium, showing again that all would not emerge the same year.

CONCLUSIONS.

From the data recorded in the preceding pages, it seems logical to conclude:

1. Adult cicadas may be transported long distances and kept in live cages for as long as three weeks, singing, mating and ovipositing normally.

2. Adults feed frequently by sucking juices from living plants. Neither nymphs nor adults are specific feeders.

3. Females of most species will oviposit in a wide variety of hosts, but show a preference for certain types of material. The number of eggs placed in each nest varies with the species and with the type of material.

4. Females of most species exude a gluelike secretion into the nest before leaving it, and when this is done their eggs are not affected by the withering of the host.

5. Eggs of different genera and species vary in appearance when laid only as to size. During maturation the eggs of some turn pink, while those of others remain white, the pink color persisting through the first-instar nymphs only.

6. The eggs of all the genera except *Tibicen* hatch the same season they are laid. All the species of *Tibicen* except two overwinter the first year in the egg stage—*Tibicen bifida* (Davis) and *Tibicen vitripennis* (Say).

7. Temperature and moisture influence the time and rate of hatching of the eggs.

8. For practical purposes the nymphs require soil to thrive.

9. Nymphs feed throughout the greater part of the year, at least, and cannot subsist on annuals.

10. Nymphs may be taken from the field, transported long distances in artificial cells and placed in cages, where they continue development.

11. Nymphs remain in the same cell if the food is satisfactory, but will burrow extensively if the host dies.

12. There are five instars, with no evidence of a pupal or resting stage before emergence.

13. The number of segments of the tarsi change from two to one and back to two again during nymphal life. The number of setæ-bearing spines on the apex of the tibiæ also change.

14. Emergence is predicted by deepening of body color in many cases, and always by darkening of eyes from white to red or black.

15. The complete life cycle may be run in captivity.

16. All Kansas cicadas have a life history covering several years. That of *Melampsalta calliopè* (Walk.), the smallest of our Kansas cicadas, is completed in approximately four years.

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EXPLANATION OF PLATES.

PLATE XXVIII.

FIG. 1. A typical habitat of *Tibicen bifida* (Davis) in Scott county, Kansas.

FIG. 2. A meadow habitat of *Melampsalta calliope* (Walk.) eleven miles west of Lawrence, Kansas.

PLATE XXVIII

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PLATE XXIX.

FIG. 1. A typical view in the Beaver Creek valley, Scott county, Kansas. The grassy plot in the foreground is the location from which the hundreds of *Melampsalta calliope* (Walk.) nymphs were taken. The persons in the foreground were observing the oviposition of this cicada at the time the picture was taken.

FIG. 2. Digging for *Melampsalta calliope* (Walk.) nymphs in Scott county, Kansas. Breaking up the sod over a dirt table.

PLATE XXIX

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PLATE XXX.

FIG. 1. *Melampsalta calliope* (Walk.) ovipositing in sweet clover.

FIG. 2. *Tibicen marginalis* (Walk.) ovipositing in dead willow.

FIG. 3. *Tibicen aurifera* (Say) ovipositing in *Panicum virgatum* near Midland, Kan., September 22, 1923.

FIG. 4. Venter of *Tibicen pruinosa* (Say), showing the more rounded opercula.

FIG. 5. Venter of *Tibicen linnei* (S. & G.), showing the pointed opercula.

PLATE XXX

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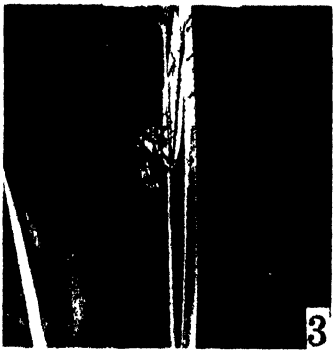
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PLATE XXXI.

FIG. 1. Enlargement of a stem of *Panicum virgatum*, showing the external opening of three nests of *Tibicen aurifera* (Say). The tissue of the plant is very carefully patted back into place by the outer valves of the ovipositor after a sticky secretion has been placed on it.

FIG. 2. Grub of a small green hymenopteron belonging to the genus *Syntomaspis,* in place in the nest of *Tibicen aurifera* (Say). Same magnification as the eggs in Fig. 3.

FIG. 3. Nest of eggs in a stem of *Panicum virgatum* made by *Tibicen aurifera* (Say). This shows the typical arrangement of the eggs in the nests of most of the species studied.

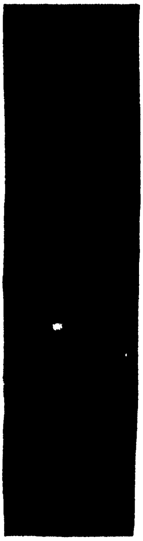
FIG. 4. Rows of nests of *Tibicen aurifera* (Say) in stems of *Panicum virgatum*. Note the even arrangement.

FIG. 5. Nests of *Tibicen dorsata* (Say) in sagebrush.

FIG. 6. Nests of *Tibicen dealbata* (Davis) in cottonwood, showing how the young limbs are macerated by the ovipositor.

FIG. 7. Nests of *Tibicen marginalis* (Walk.) in birch. The smaller twigs are often killed by oviposition.

PLATE XXXI.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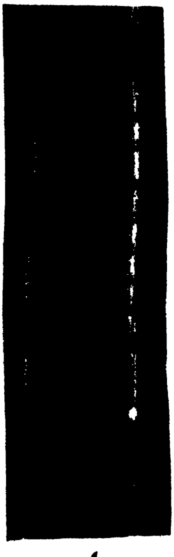
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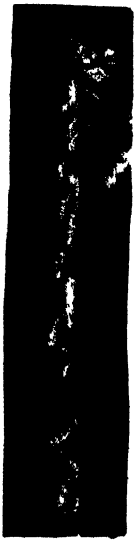
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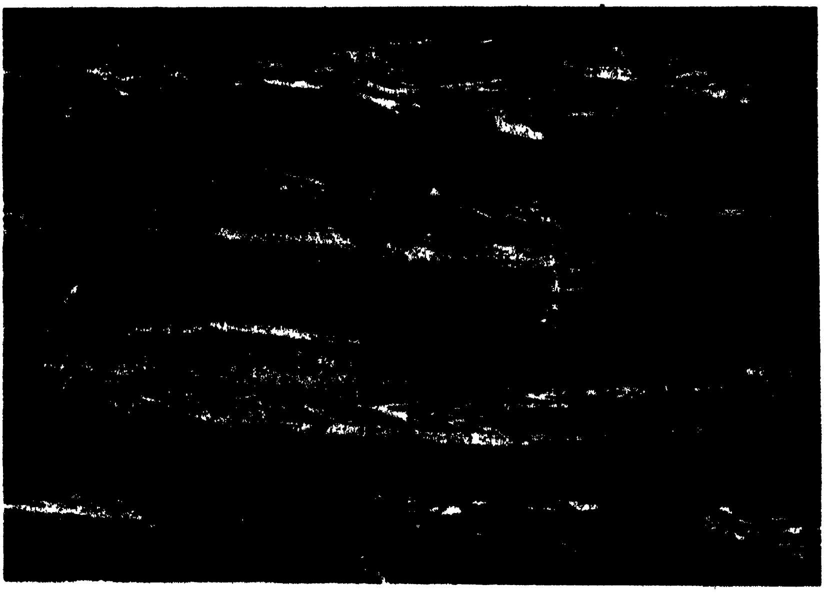
PLATE XXXII.

FIG. 1. Scars on birch limbs one year after oviposition by *Tibicen marginalis* (Walk.).

FIG. 2. Nests of *Melampsalta calliope* (Walk.) in sweet clover. Some idea of the number and arrangement is shown. Very often not a single branch of the entire plant escapes.

PLATE XXXII.



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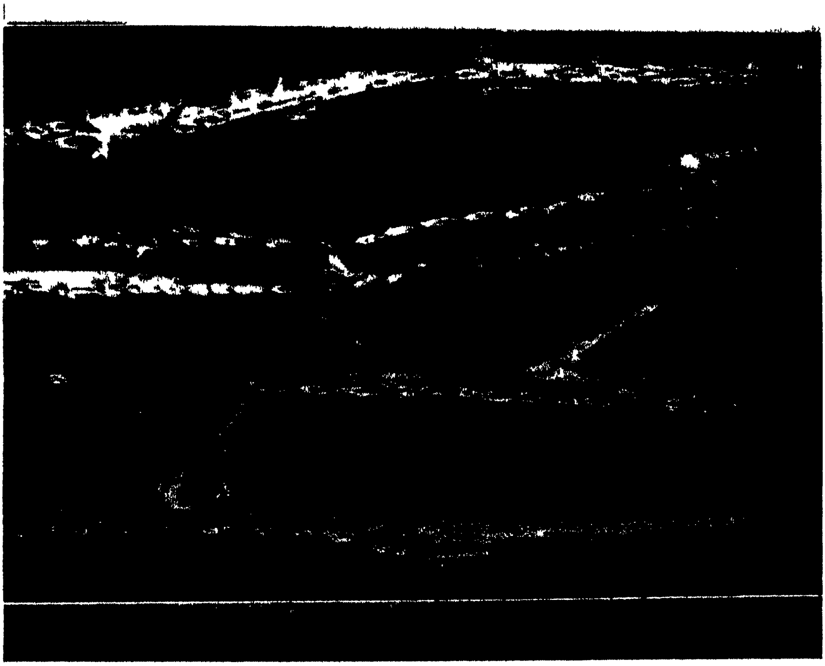


PLATE XXXIII.

FIG. 1. A cage using 8 by 10 glass, containing nymphs of the seventeen-year cicadas. One of the nymphs dug through the base of the cage in the left-hand corner.

FIG. 2. Bottom of the cage shown in Fig. 1, with the exit hole of the *Magicicada septendecim* (Linn.), fifth-instar nymph.

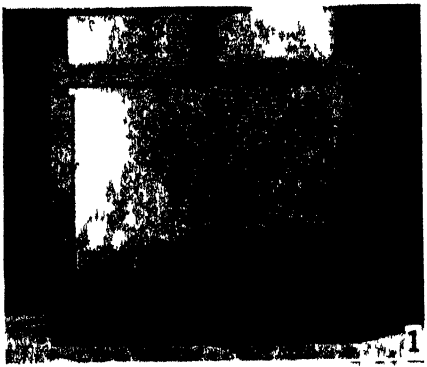
FIG. 3. A large pot of *Panicum virgatum*, showing the extensive root mass.

FIG. 4. Lump of dirt broken open, showing a fifth-instar nymph, seventeen-year cicada's cell and nymph.

FIG. 5. A large potato containing four fifth-instar seventeen-year cicada nymphs in artificial cells. The cells are closed with small squares of celluloid inserted in slits in the potato.

FIG. 6. A small glass-sided cage containing orchard grass from which a *Melampsalta calliope* (Walk.) nymph has just emerged. Part of the tunnel is shown as well as the exuvium just to the right of the plant.

PLATE XXXIII.



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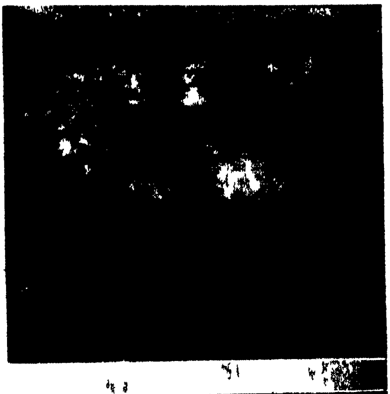

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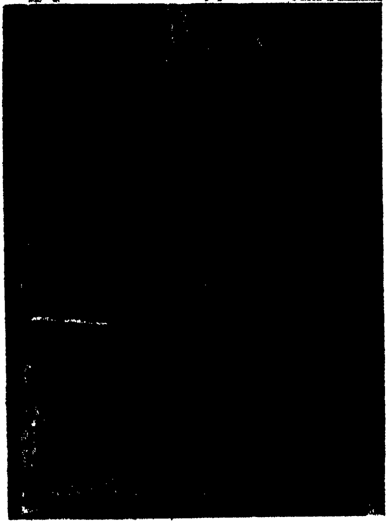

PLATE XXXIV.

FIG. 1. *Tibicen aurifera* (Say) mating on a compass plant near Garnett, Kan., September 7, 1926.

FIG. 2. A close view of some of the hard, stubby limbs of the oak, *Quercus marilandica*, in which *Cicada hieroglyphica* Say delights to make her nests.

FIG. 3. Nest of *Tibicen dealbata* (Davis) in cottonwood, side view, showing three eggs and the torn tissue at (*a*) which is pushed up to close the nest. This is accomplished by an additional insertion of the ovipositor. The material is held in place by a secretion.

FIG. 4. *Tibicen bifida* (Davis) ovipositing in the flower stalk of a yucca plant in Scott county, Kansas.

FIG. 5. Live cage on elm for *Tibicen pruinosa* (Say). The adults live, apparently content, in this type of cage. The mosquito netting from which they are made does not injure the specimens when they fly against it.

PLATE XXXIV

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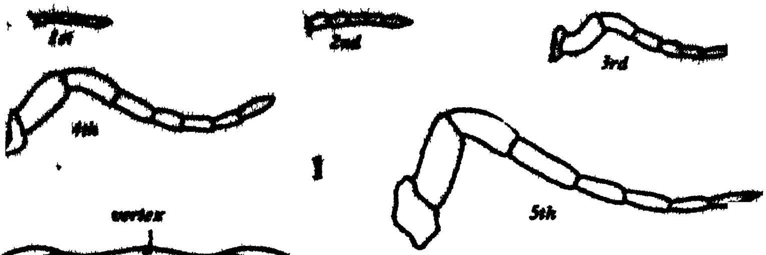
PLATE XXXV.

FIG. 1. Right antennæ of various instars of *Melampsalta calliope* (Walk.)
FIG. 2. Caudal aspect of the head of *Melampsalta calliope* (Walk.).
FIG. 3. Dorsal aspect of the head of *Melampsalta calliope* (Walk.).
FIG. 4. Lateral aspect of the head of *Melampsalta calliope* (Walk.).
FIG. 5. Cephalic aspect of the head of *Melampsalta calliope* (Walk.).

PLATE XXXV.



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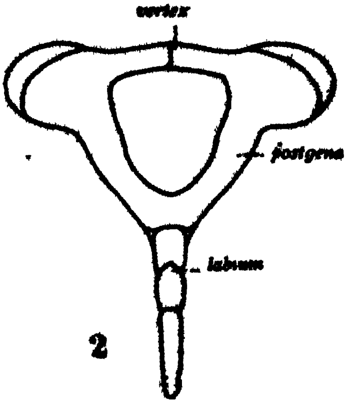

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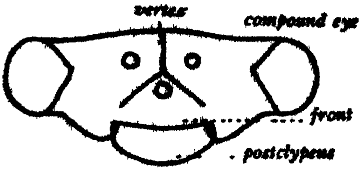

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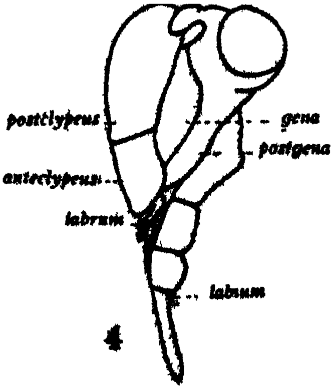

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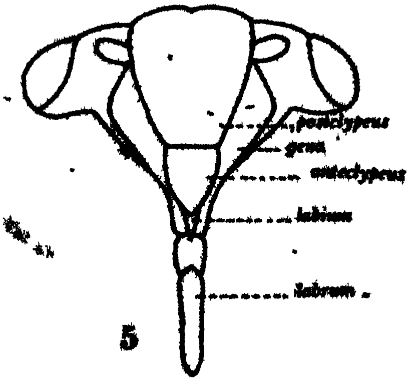

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PLATE XXXVI.

Morphology of the adult of *Melampsalta calliope* (Walk.).

FIG. 1. Cephalic view of prothorax.

FIG. 2. Lateral view of prothorax.

FIG. 3. Dorsal aspect of prothorax.

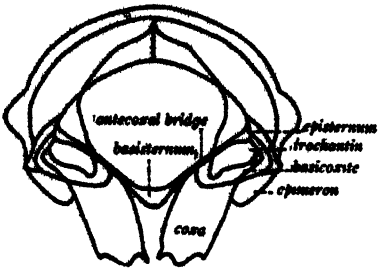
FIG. 4. Ventral view of thorax.

FIG. 5. Dorsal aspect of meso- and metathorax.

FIG. 6. Ventral view of the abdomen of ♀ (female). *Is*, first abdominal sternite; *IIs*, second abdominal sternite, etc.

FIG. 7. Ventral aspect of abdomen of male. *Ist*, first abdominal sternite; *VIIIs*, eighth abdominal sternite.

PLATE XXXVI.



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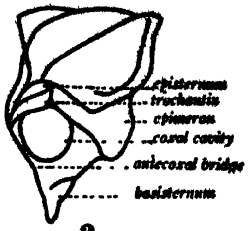

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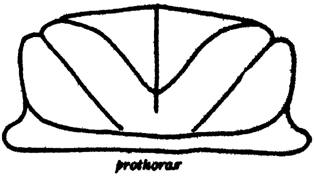

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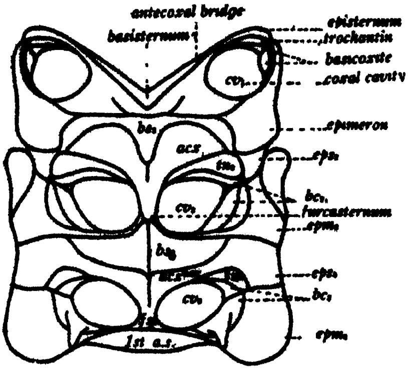

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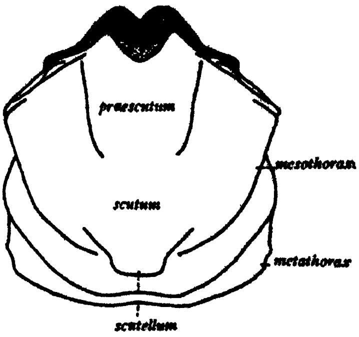

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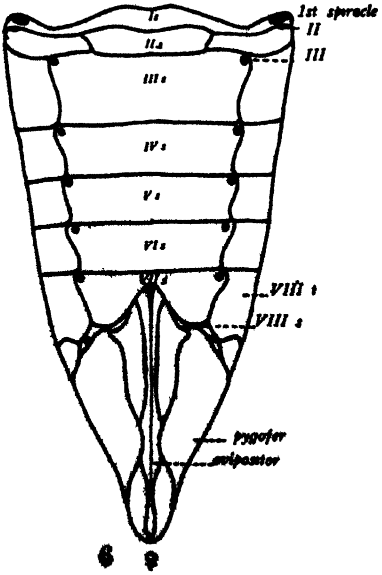
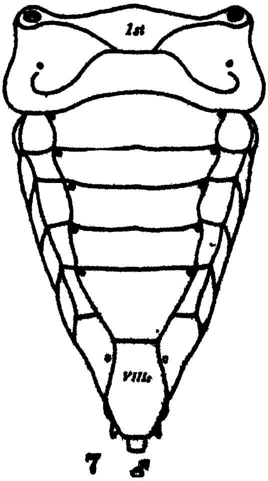


6 ♀



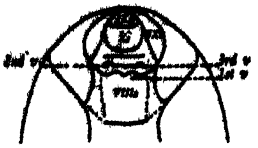
7 ♂

PLATE XXXVII.

Melampsalta calliope (Walk.).

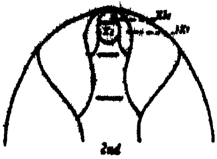
FIG. 1. Tip of abdomen of first instar. *XIs*, eleventh sternite, etc.
FIG. 2. Tip of the abdomen of the second instar.
FIG. 3. Tip of the abdomen of the third instar ♀ (female). *1st v*, first pair of valves of ovipositor; *2nd v*, second pair of valves, etc.
FIG. 4. Tip of the abdomen of the third instar ♂ (male).
FIG. 5. Tip of abdomen of fourth instar ♀ (female).
FIG. 6. Tip of the abdomen of the fourth instar ♂.
FIG. 7. Tip of the abdomen of the fifth instar ♀.
FIG. 8. Tip of the abdomen of the fifth instar ♂.
FIG. 9. Ventral view of œdagus.
FIG. 10. Lateral view of œdagus.
FIG. 11. Lateral view of tip of ♂ abdomen.
FIG. 12. Tenth and eleventh tergites with appendages enlarged.

PLATE XXXVII.



♀ 3rd

3



2nd

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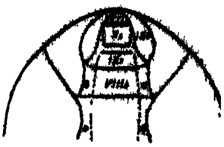
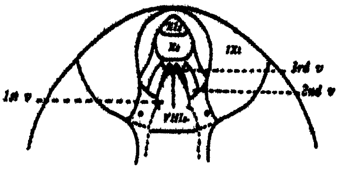


♂ 3rd.

4



♀ 4th

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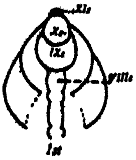

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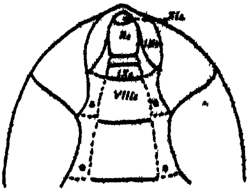

♂ 4th

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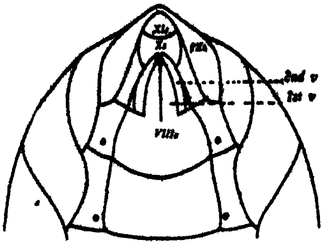

♀ 5th

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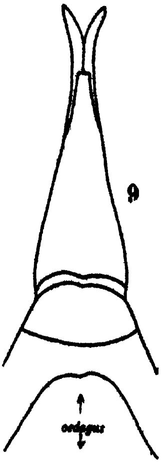

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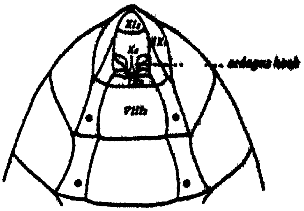

♂ 5th

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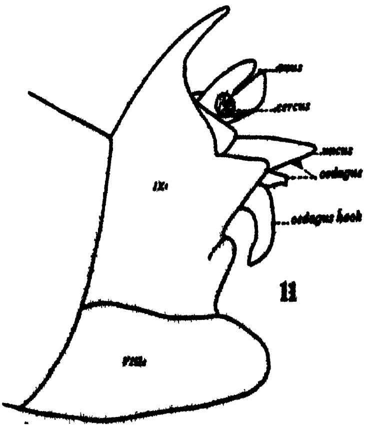

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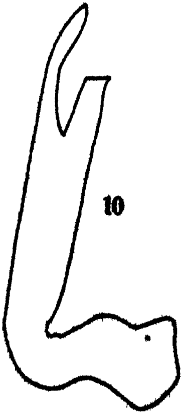

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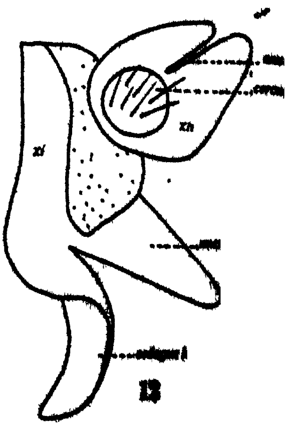

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PLATE XXXVIII.

FIG. 1. Front legs of the nymphal instars of *Melampsalta calliope* (Walk.) drawn to scale. Note the development of the comb.

FIG. 2. The front legs of all instars and adult of *Cicada hieroglyphica* Say drawn to scale, with the exception of the first, which is larger.

FIG. 3. A nest of *Proarna venosa* (Uhl.) in the dry, fruiting stem of a grass.

FIG. 4. A nest of *Melampsalta calliope* (Walk.) in a stem of sweet clover, showing the fan-shaped arrangement sometimes used.

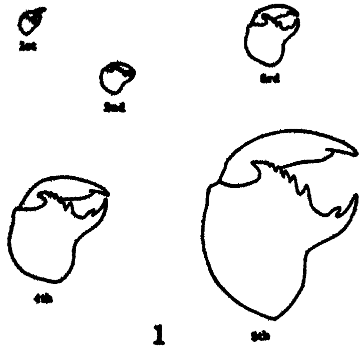
FIG. 5. Eggs of *Tibicen chloromera* (Walk.) in a dead elm limb. Note the secretion in the outer end of the nest.

FIG 6. Apex of tibia and tarsi of nymphal instars and adults of *Melampsalta calliope* (Walk.). Note that the first instar has two tarsal segments, the second, third and fourth have but one, the fifth has two, and the adult three. All views of the right hind leg.

FIG. 7. Front leg of the fourth instar nymph of *Melampsalta calliope* (Walk.). (*a*) Femur; (*b*) tibia; (*c*) tarsus; (*d*) comb.

FIG 8. Front leg of the fifth-instar nymph of *Melampsalta calliope* (Walk). Lettering same as in Fig. 7.

PLATE XXXVIII.



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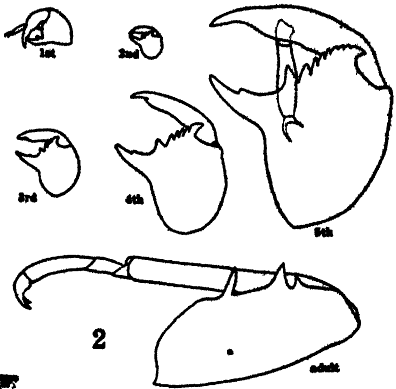

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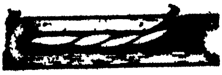

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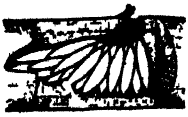

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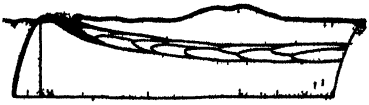

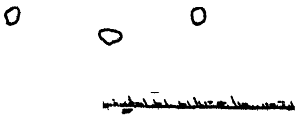

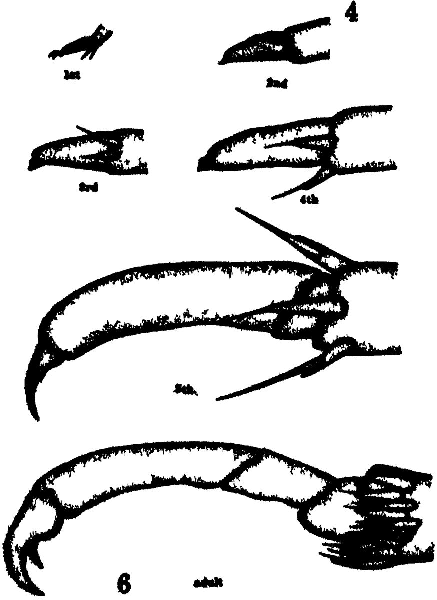

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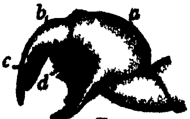

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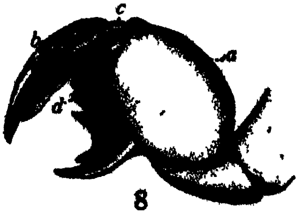

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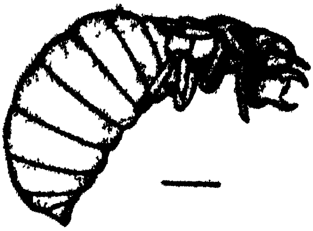
PLATE XXXIX.

Melampsalta calliope.

Fig. 1. Egg × 20.
Fig. 2. First instar × 20.
Fig. 3. Second instar × 10.
Fig. 4. Third instar × 10.
Fig. 5. Fourth instar × 5.
Fig. 6. Fifth instar × 5.
Fig. 7. Adult × 5.

PLATE XXXIX.



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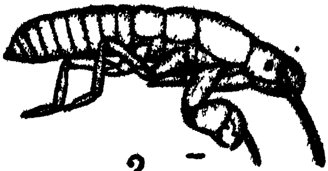

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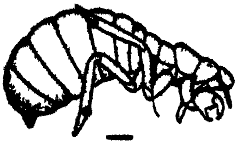

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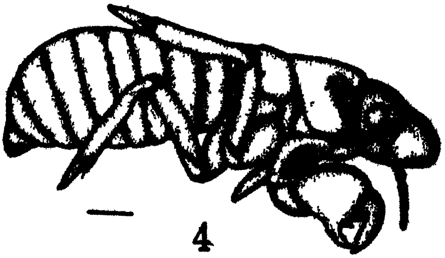

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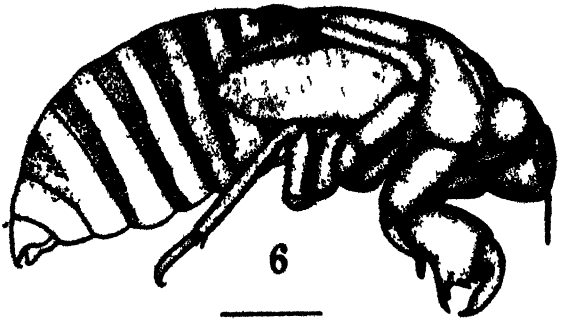

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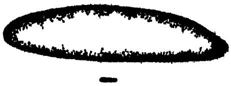

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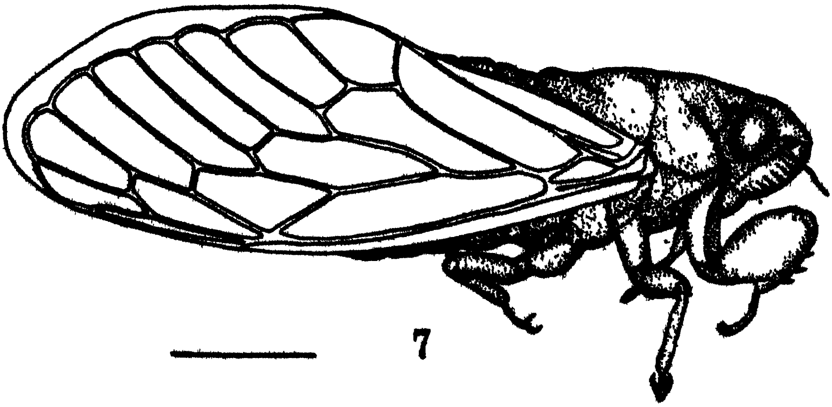

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PLATE XL.

Proarna venosa (Uhl.)

Fig 1. The egg × 20.
Fig 2 First instar × 20.
Fig 3. Third instar × 8.
Fig. 4 Fourth instar × 8.
Fig. 5. Fifth instar × 5.
Fig. 6 Adult × 5.

PLATE XL.

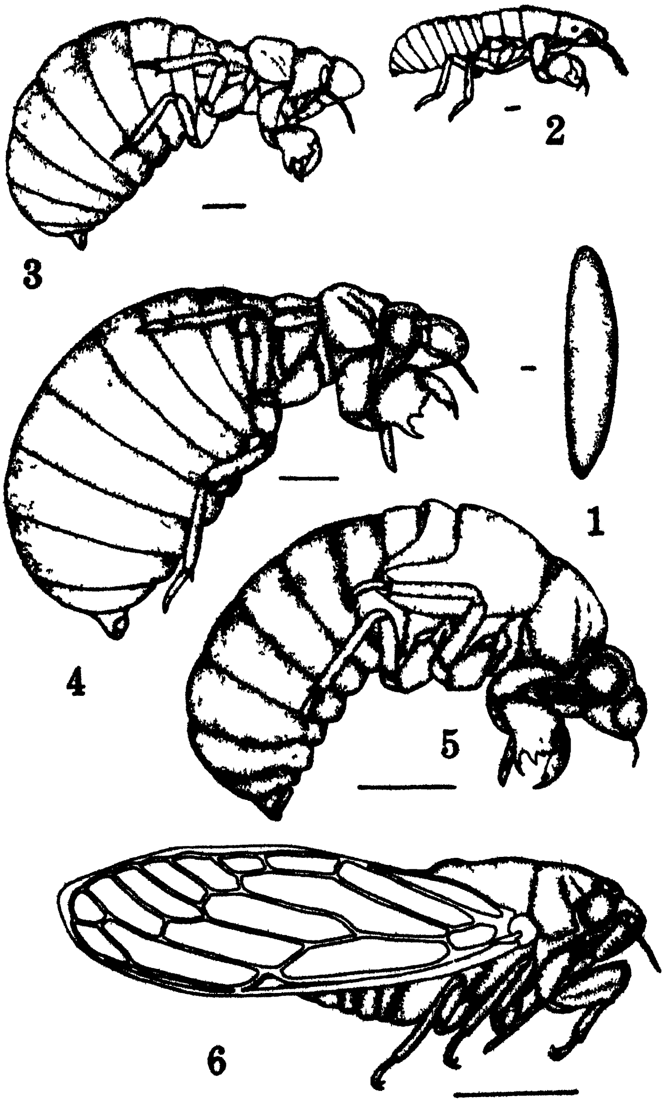
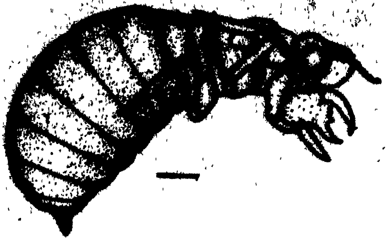


PLATE XLI.

Cicada hieroglyphica Say.

Fig 1 The egg × 20.
Fig 2 First instar × 20.
Fig 3 Second instar × 10
Fig 4 Third instar × 8
Fig 5 Fourth instar × 5
Fig 6 Fifth instar × 5.

PLATE XLI.



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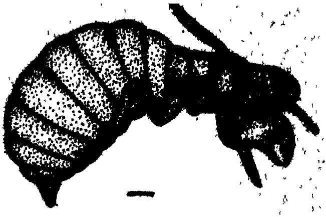

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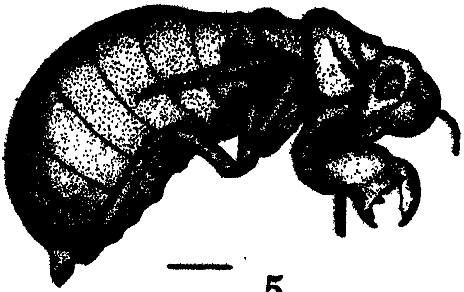

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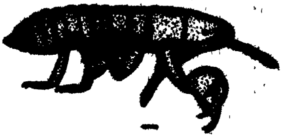

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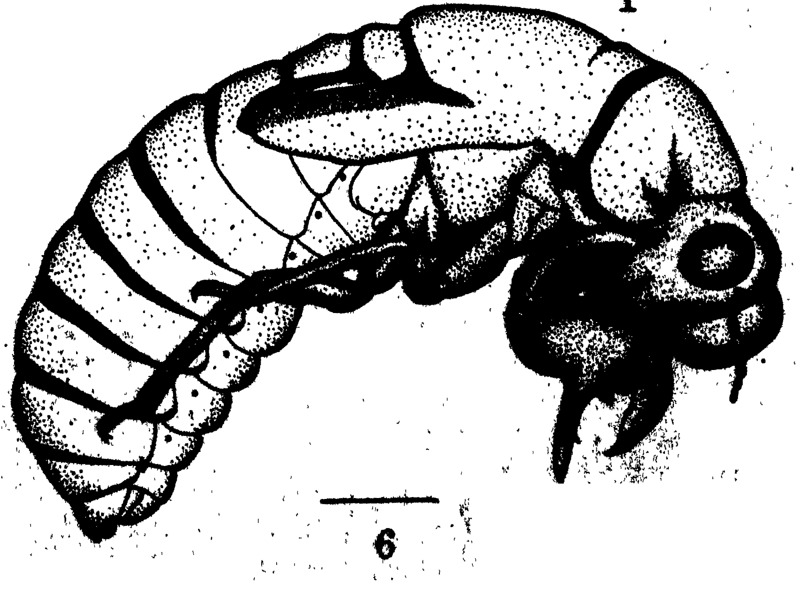

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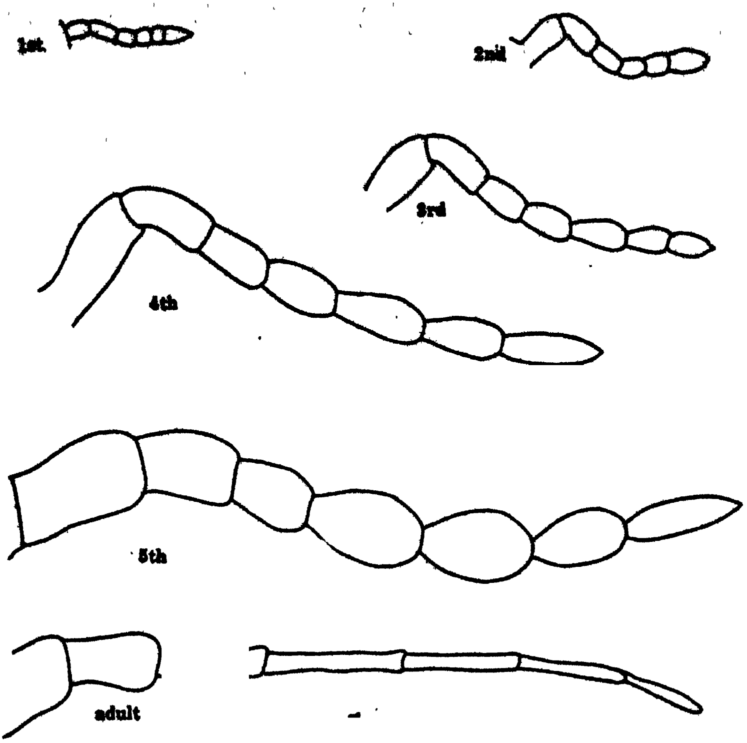
PLATE XLII.

Cicada hieroglyphica Say.

FIG. 1. The antennæ of the nymphal instars and the adult drawn to scale. Note the bulblike tendency of some of the joints of the nymphal antennæ.

FIG. 2. Tip of hind leg of all nymphal instars and adult, showing tarsal segments and setæ-bearing spines as well as the tarsal claws.

PLATE XLII.



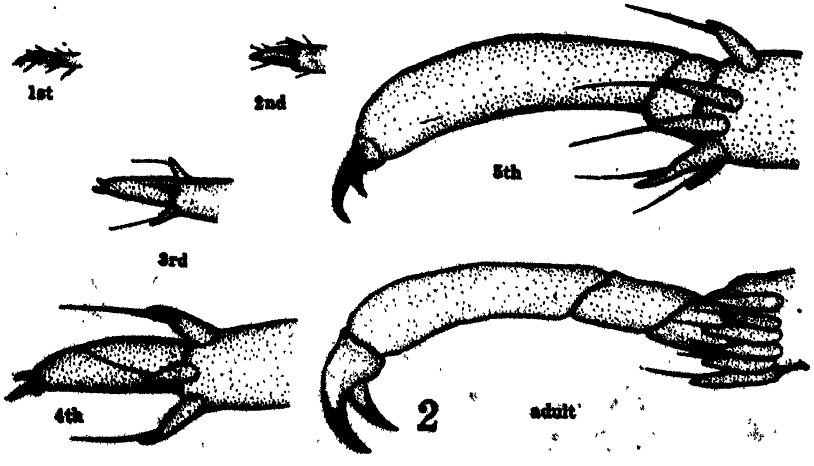


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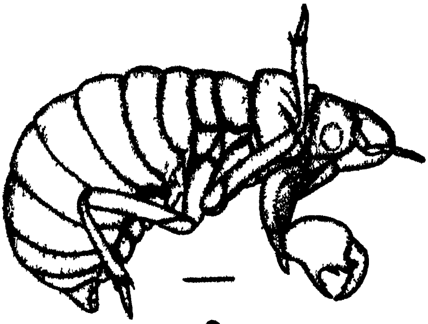
PLATE XLIII

Tibicen aurifera (Say).

Fig 1 First instar × 20
Fig 2 Second instar × 10
Fig 3 Third instar × 8
Fig 4 Fourth instar × 5
Fig 5 Fifth instar × 5
Fig 6 The egg × 20

PLATE XLIII.



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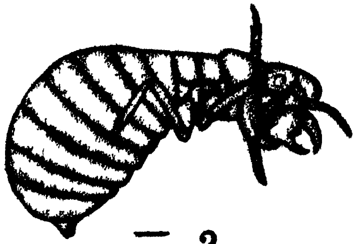

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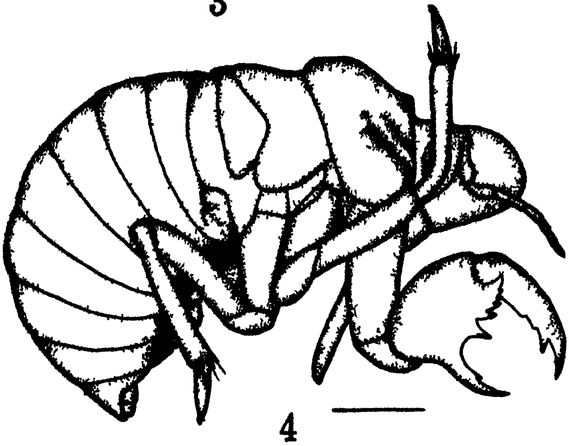

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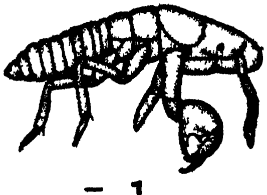

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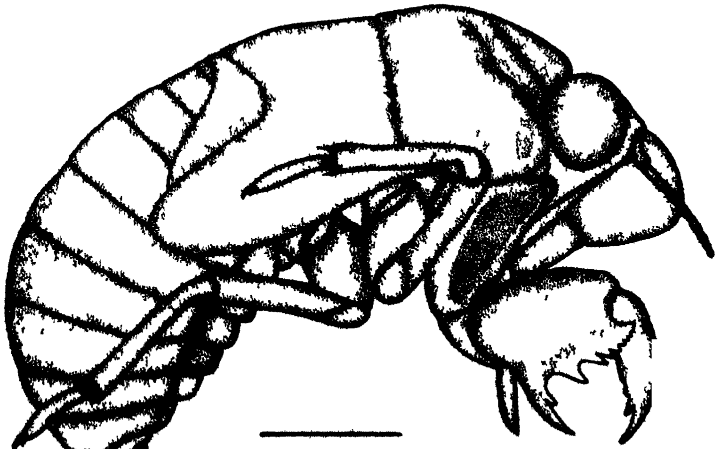

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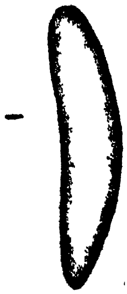

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XVIII.] APRIL, 1928. [No. 3.

Hæmoglobin Cells and Other Studies of the Genus *Buenoa* (Hemiptera, Notonectidæ).*

CLARENCE O. BARE, Department of Entomology.

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INTRODUCTION.

THE purpose of this paper, after about one year's study, is to give what additional knowledge has been secured for the genus *Buenoa* of the family Notonectidæ. It applies especially to *Buenoa margaritacea* Bueno with its recently discovered hæmoglobin cells. While the study began with these very interesting cells, it has extended to and included life-history observations, external and internal morphological studies, genitalia, and specific characters upon which distinct species may be based.

In the *Canadian Entomologist* for November, 1922, Dr. H. B. Hungerford, of the University of Kansas, reported the presence of oxyhæmoglobin in definite cell clusters in the above-named species. This he proved by means of a spectroscopic test, the hæmin crystal test, and chemical tests such as Weber's guaiac test for blood. All the tests gave positive results, and he wrote:

---

* Submitted to the Department of Entomology and the faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

> ". . . And we are thus able to report that we have in this case an insect containing definite, bright red clusters of cells, enmeshed and closely associated with the tracheal system of the abdomen, which contain oxyhæmoglobin.
>
> "In the case of *Chironomus* (the bloodworm), which has been cited frequently as the only insect possessing hæmoglobin, the red fluid is free in the body cavity, and when the larva is punctured flows out at once Rollett (72) in 1861 discovered hæmoglobin crystals in this pigmented material and Lankester (47) in 1867 noted that it gives the characteristic absorption spectrum of hæmoglobin Cuenot (21), 1891, who investigated the blood and lymphatic systems of many vertebrates and invertebrates, is often cited in connection with the above case "

Then follow his remarks on the only other known example besides *Buenoa* of an insect containing hæmoglobin cells in definite attached clusters, and he says:

> "A case more interesting, and structurally more like the one I am reporting, is that of the larva of *Gastrophilus equi* Berlese (3) gives a discussion of the literature relating to the discovery and study of certain pink cells related to the tracheal system in these botfly larvæ He cites Vaney (81) as showing that the red color of these 'cellules tracheales' is due to hæmoglobin, which he appears to have thought was secured in some manner from the host. Vaney found further that the hæmoglobin tended to disappear following the larval period. Both the above-mentioned records are in the Diptera We are pleased, therefore, to report the presence of oxyhæmoglobin in definite cell clusters in the free-swimming aquatic hemipteron *Buenoa,* and to suggest that it is, no doubt, present also in the closely allied genus, *Anisops* * Since these insects are not parasitic, the hæmoglobin is produced by them, and has a normal physiological function to perform "

In a footnote at the bottom of the page he has stated that "a complete study of the histology and development of these interesting cells is under way." It is in accordance with this footnote that these studies have been undertaken

Since the work started it was stated that a careful study should be made of the genitalia and other structures, for it was felt that the genus contained several other species as yet undescribed because of the dearth of specific characters upon which to base them. So, in addition, these studies have been worked out as carefully as the time and materials available have permitted, and they are grouped together in this paper with the hope that they will become a valuable part of the knowledge of insect life.

Much appreciation is due to Dr. H. B. Hungerford for the materials he has loaned, for his kindly suggestions and encouragement, and for his guidance in the conduct of these studies; also, to Dr. P. B. Lawson for his aid in the morphological studies; and to Miss Kathleen Doering, Mr. P. A. Readio, Mr. R. H. Beamer, Mr. William Robinson, or any others who may have assisted in any way or been interested in these problems.

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* See Poisson *Anisops producta* Fieb , in Archives de Zoölogie Experimentale, T 65, Fas. 4, pp 182-208, 1926 Since the completion of this thesis, ten pages and six figures are devoted by this European worker to the hæmoglobin cells or "cellules tracheales" of the genus *Anisops*

In order to more fully understand the group of insects here considered, it may be well to mention the more important fact of their phylogenetic and systematic relationship, life history, and other points of more general interest before beginning with the more specific parts of the investigation. The Notonectidæ belong to that great group of the Hemiptera-Heteroptera, sometimes called the Cryptocerata, and seem to be closely related to the Corixidæ.

TAXONOMY.

In University of Kansas Science Bulletin, volume XI, page 165, Doctor Hungerford discusses the family Notonectidæ as follows:

> "The family Notonectidæ embraces, according to Kirkaldy, two subfamilies, Pleinæ and Notonectinæ. In his 'Revision of the Notonectidæ, part I,' in Trans. Ent. Soc. London (3), Vol. 35, pp. 393-426, 1897, this author begins his systematic revision of the family. This is continued in a second paper which appeared in the 'Weiner Entomologischen Zeitung' for 1904, and entitled 'Uber Notonectiden.'
>
> "In the following year Bueno published 'The Genus *Notonecta* in America North of Mexico.'
>
> "Kirkaldy lists six genera in the subfamily Notonectinæ: *Notonecta* L., *Anisops* Spin., *Enithares* Spin., *Martarega* B. White, and *Nychia* Stal. It is in his second paper that he erects the genus *Buenoa* which is allied to *Anisops*. In this country we have the three genera: *Notonecta, Buenoa* and *Plea*. These may be separated by the following:
>
> KEY TO GENERA.
>
> A. Legs quite similar .... *Plea* Leach.
> AA. Legs dissimilar, hind legs flattened and fringed for swimming.
>   B. Last segment of antennæ much shorter than the penultimate...... *Notonecta* Linn.
>   BB. Last segment of antennæ longer than the penultimate.............. *Buenoa* Kirk.
>
> "Of these three genera *Notonecta* is the commonest, being represented in this country by 12 species; the genus *Buenoa* comes next, with 5," (now 7), "while the little *Plea* so far is credited in the literature with but 1."

Since the above was published Doctor Hungerford has described two other species, and the genus *Buenoa* now contains 7 species instead of 5 in this country.

Dr. Carl Drake has since described *Plea harnedi:*

In the same publication on page 173 the genus *Buenoa* is described as follows:

"Genus *Buenoa* Kirkaldy.

"Named in honor of Mr. J. T. de la Torre Bueno.

"Similar to the genus *Anisops*, but the male is provided with two tarsal segments on the front legs, and claws are differently formed.

"Head: Eyes not contiguous, but interior margins about parallel, their margins curving slightly, making distance at vertex greatest, and interocular space long and narrow. Labrum reaching to apex of second rostral segment; last segment of antenna longer than the penultimate.

"Thorax: Pronotum not most transverse; alæ present and the hemelytra divided into clavus, corium and membrane, and more transparent and hyaline than in *Notonecta*. Hind femora not reaching apex of hemelytra. The hind tarsi are provided with more conspicuous claws than *Notonecta*. The middle and front legs are armed with long spines and the males of *Buenoa elegans* and *Buenoa margaritacea* at least are equipped on the front leg with a tibial structure borne on the inner face of a prominence, which is forced into a thin, elongate spur by the elevation of the inner angle or margin of the tibia near its base. Tarsi of front legs two-segmented in both sexes.

"Abdomen: The abdomen is provided with a median ventral carina and the lateral margins of the venter are provided with guard hairs which cover the 'gutters.' The female has the last ventral abdominal segments modified for sheathing the ovipositor, which consists in the main of a pair of somewhat spatulate chitinized gonapophyses for placing the eggs in the tissues of plants."

The following key is proposed to include the species now found and described in the United States. It is probable that *B. platycnemis* (Fieber) does not exist here.

KEY TO *BUENOA*.

A. Scutellum broad and as long or longer than the pronotum.
  B. Pronotum in the male with four depressions, appearing tricarinate
    C. Head with eyes in male nearly as wide as pronotum, a little narrower in female; legs robust; length 7.5 to 9 mm. . . . *B carinata* (Champion)
    CC. Head with eyes somewhat flattened and distinctly narrower than pronotum in both sexes; legs slender; pale color; length 6 5 mm. *B. albida* (Champion)
  BB. Pronotum almost unimpressed, lateral carinæ in some males.
    C. Small oval stridular area on front femur of males; length 6.7 to 8.1 mm. .... *B margaritacea* Bueno
    CC. Long sword-shaped stridular area across front femur of males; length 6 5 to 7.5 mm. .... *B. scimitra* n. sp.
AA. Scutellum reduced and narrow and not as long as pronotum.
  B. Species over 6 mm. long.
    C. Pronotum of male large, inflated, and smooth; length 6.25 to 7 mm. *B. limnocastoris* Hungerford
    CC. Pronotum of male tricarinate; large tibiæ in front; length well over 6 mm. .... *B. macrotibialis* Hungerford
  BB. Species less than 6 mm. long.............................. *B. elegans* (Fieber)

BIOLOGY OF THE GENUS.

Concerning the biology and life history of the species of the genus *Buenoa* apparently very little has been written except about *Buenoa margaritacea* Bueno. All the notes found are those by Doctor Hungerford (36 and 37). The observations added herein are confined to the above or very nearly related species.

EGGS AND OVIPOSITION.

Concerning the eggs the statement is confirmed that they are placed in the tissues of plants with a bit of the surface exposed. Most of those collected have been from a species of *Ceratophyllum* growing in a permanent pond underneath a Union Pacific railroad bridge about two miles north of Lawrence, Kan. At times only a single egg here and there has been found in the stem of this plant, nearly always with the cephalic end of the egg toward the bottom of the plant. The portion of the stem chosen varied from within a few inches of the tip of the growing stem to near the base of the plant where the stem was tougher, larger, and much discolored. Usually the eggs were more numerous, and most frequently found near the middle of the growing stem where the tissue was neither too hard nor too soft, and apparently of just the right consistency for oviposition.

Of the hexagonal reticulations of the egg surface mentioned in University of Kansas Science Bulletin, volume XI, page 195, it is found for the eggs of *B. margaritacea* that these reticulations are confined to the area immediately surrounding the micropyle or area exposed as the egg lies *in situ*. Each hexagonal area has a finely corrugated or granular appearance. The rest of the chorion appears quite smooth.

Specimens of *B. margaritacea* collected from Smith's pond one mile east of Lawrence on April 15, 1924, were placed in an aquarium jar with a long stem of *Ceratophyllum* and left sitting in a window of the laboratory. Two eggs were first observed deposited in the stem on the morning of April 24. On April 28 they were observed under the binocular, and it was found that the red eyespots were well developed. On the morning of April 30 they were found to have hatched and died almost immediately for some unknown reason.

After that date the eggs were found in the pond, and stems were brought to the laboratory and examined to find that the eggs had already hatched as early as May 5. Around May 10 eggs were quite easily found in the pond or secured by bringing live bugs from the ponds and placing them in an aquarium jar together with some *Ceratophyllum.* Most of the eggs were laid the first day or two after the bugs were brought into the laboratory. Then the bugs died one by one, until within three weeks they were all dead. The cause of their death was not determined. It may have been lack of proper food, the growth of a scum over the surface of the water in the aquarium jars, the fact that they had laid their eggs and were dying normally, or other reason. They do not appear to die in this manner in the ponds.

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* See, also, Bare: Life Histories of Some Kansas Backswimmers, pp. 93-101, Annals Ent. Soc. Am., Vol. XIX; 1926.

In the spring of 1923 the eggs were found from May 12 to June 6. No doubt they were laid much earlier than the first findings. Search was made for them last on about July 1, but none were found. But at that time many nymphs of all stages were found, and during the early days of September and as late as October 22 fifth-instar nymphs were collected from ponds about Lawrence. It seems probable, then, that egg laying continues from as early as April 24, to sometime in August, and there may be more than one generation in a season.

The egg stage from time of oviposition to hatching is about one week. At this writing only one hatching has been secured from eggs the date of oviposition of which was nearly known. From eggs collected in May, 1923, those which hatched would seem to verify the above statement.

Observations on the oviposition of *B. margaritacea* are as follows: At 7:20 a. m. May 15, 1924, a bright, sunny, cool morning, in an aquarium jar sitting in the shade at an east window through which the sun was shining, a female was first observed depositing her eggs in the stem of a species of *Ceratophyllum.* The stem was inclined at an angle of about 45 degrees at the place where the egg was deposited. The bug when first observed was standing above the stem, back upward, so that the body and stem formed an angle of about 30 degrees. Other observations later showed the bug on nearly every side of the stem, and the position of the stem seemed to make little difference. Sometimes two eggs were laid almost side by side or just opposite each other in the same stem. The front pair of legs were fully extended almost perpendicular to the line of the body and grasped the stem of the plant rigidly. The middle, or mesothoracic, legs were extended caudally and grasped the stem at an angle of about 45 degrees with the line of the body. They were not fully extended, but stood in an elbowlike position allowing considerable freedom of motion. The hind, or metathoracic, swimming legs extended laterally like balancing apparatus and ready to make the swimming stroke as normally. The tip of the abdomen was extruded and bent downward to the stem. The last exterior or seventh abdominal sternite, which has a sharp pointed caudal tip, was standing at an angle of about 40 degrees to the line of the body and was inserted into the plant tissues like a wedge.

The two sicklelike blades of the ovipositor were digging simultaneously into the stem with a backward scooping motion, and under the binocular the fragments of plant tissue like sawdust were seen floating away in the water. The movement of the ovipositors seemed to be due partly to a slight backward and forward movement of the entire body and partly to the movements of the muscles of the eighth and ninth segments of the abdomen. As the work progressed the ovipositors were inserted deeper and deeper, hollowing out the space downward and backward for the insertion of the egg, and the seventh sternite, acting as a wedge, was shoved deeper into the stem. When the opening was ready the two black-tipped styli at the tip of the abdomen were pushed against the tissue on either side of the more caudal part of the incision to help keep it open. The ovipositors were apparently used literally as levers against the edges. The bug rested for a moment, and then the egg was pushed into its receptacle by contraction of the opening of the oviduct a little above and between the ovipositors. The bug rested a few seconds longer, and then withdrew the ovipositors and sternite and swam away.

The aquarium jar in which the above observations were made contained about 40 or 50 bugs taken the evening before and placed in the jar about 4:30 p. m., together with a stem of *Ceratophyllum* about 15 inches long collected several weeks before, and in which no eggs had been previously deposited. At 7 p. m. of the same evening it was observed that the stem contained 3 eggs freshly deposited. At 7 a. m. of the next morning it contained at least 18 eggs. During the morning and again in the afternoon other bugs were seen depositing eggs. The day was partly cloudy and at about 4:30 p. m. it became quite cloudy. After that no more eggs were laid. The weather conditions seem very much to affect their activities in this respect as well as in taking flight, which is described on another page. Just previous to the clouding over at 4:30 p. m., between the hours of 2:30 and 4:30 p. m., egg laying was quite active, and most of the members of the department had an opportunity to observe it.

The time of oviposition was taken repeatedly and found to be about one and one-half minutes. Sometimes the bug would leave the place where she had been working with her ovipositor. Sometimes she seemed to be disturbed by her observers (all the *Buenoa* are quite wary) and again it seemed that the place sought did not prove satisfactory. After a trial was made of a place she would always go to the surface for a fresh supply of air before trying another place. Then she would swim quietly around till a suitable place on the stem between two nodes was found. Next she would quickly turn and grab it with the two pairs of front legs, and begin to test it with the tip of the seventh sternite and the ovipositors. If it was found suitable she would not change her position, but if not she might crawl along the stem for some distance until she found a better place. The ovipositors began working immediately when she took hold of the stem. The time required to make the opening complete for the egg was almost precisely one minute. Then she would rest about five or ten seconds and lay the egg. After another rest of ten to twenty-five seconds she would swim away. Fifteen separate observations were made of the process of oviposition in one day, and it has been noted repeatedly since.

Sometimes the bug encountered difficulty with the air contained in the cells or vessels of the plant tissue. When she was through laying the egg and started to swim away she found that a large air bubble had collected, apparently from the pierced plant cells, under the tips of her hemelytra. Then she would swim about for a time somewhat like a dog with a tin can attached to its tail until the bubble was absorbed in the water or lost at the surface. It is not certain whether the bubble of air came from the plant tissue, but it appeared to do so. It may have come from beneath the hemelytra.

It is not yet determined whether the same bug lays more than one egg in a day. From dissection it is known that the abdomen of the female sometimes contains from ten to fifteen eggs of nearly the same stage of development. It is not known how many eggs a single female may lay.

NYMPHS.

Concerning the nymphs little is added to that already known and written. Attempt is being made to further trace out the life history and length of the instars. If the success is no better than former experiences it will probably get them through to the second instar, and then all will die from confinement, improper food, or other such cause.

IDENTIFICATION.

For the purposes of aiding in identification of the different instars and distinguishing the sexes of both adults and nymphs, the following notes are given and the reader referred to pages 195-197 of the University of Kansas Science Bulletin, volume XI, for a table containing other measurements and information. The notes on the following pages apply, except as to size, to *Buenoa margaritacea*, our most common species. They may apply in nearly all other characteristics to any of the *Buenoa* species. In all cases of nymphs and adults the seventh abdominal segment appears superficially to be the sixth abdominal segment instead, because the first two abdominal segments next the thorax are so fused together that it takes careful study to distinguish them.

ADULTS.

MALES:

1. V-shaped base of beak. (On the outer faces of this V-shaped segment are sound devices.)
2. Sound devices on front tibia, femur and coxa.
3. Black glandular spot near the junction of the pleurites of the first and second abdominal segments.
4. Black spine on sinistro-caudal margin of the seventh tergite.
5. Asymmetrical genital claspers, left or sinistral one larger and hooked at the end.
6. Seventh abdominal sternite somewhat rectangular.
7. Eighth abdominal sternite visible ventrally.

FEMALES:

1. Seventh abdominal sternite projects caudad into a V-shaped tip beneath the ovipositors and tip of the abdomen.
2. Symmetrical, sword- or sickle-shaped, saw-toothed ovipositors.
3. Seventh abdominal tergite symmetrical.
4. Eighth abdominal sternite not visible ventrally.
5. Styli visible near tip of abdomen, and black tipped.

NYMPHS.

A distinguishing feature of all the instars of the nymphs to separate them from the instars of *Notonecta* nymphs with which they are likely to be confused, is that the abdominal spiracles appear large and of the same general appearance as in the adult *Buenoa*. Those of *Notonecta* are small and inconspicuous.

There are also other structural differences which are noticeable. After one has studied the ventral plates of the seventh abdominal segments he can usually be pretty sure of the sex and instar to which a nymph belongs. This is especially true after the second instar. For appearance of the ventral plates of the fifth-instar nymphs see plate LVII. The females are usually larger and wider between the eyes than the males. This is also true of the adults. In all instars the beak is four-segmented, and tarsi are one-segmented and have two prominent claws. The tarsi of the adults are all two-segmented and the tarsal claws of the swimming legs are inconspicuous.

FIFTH-INSTAR NYMPH:

1. About 5.175 mm. long, etc.
2. Wing pads extend full length of the metathorax or to the distal ends of the hind coxæ.

Males: Seventh abdominal sternite somewhat rectangular.
Females: Seventh abdominal sternite triangular at tip.

FOURTH-INSTAR NYMPH:

1. About 4.5 mm. long, etc.
2. Wing pads extend to middle of metathorax or to distal end of mesothoracic tibiæ when flexed.

Males: Seventh abdominal sternite rectangular.
Females: Seventh abdominal sternite triangular.

THIRD-INSTAR NYMPH:

1. About 3.225 mm. long, etc.
2. Wing pads mere buds, or extending to line or trochanter of fore leg flexed.

Sexes rather hard to distinguish but some difference similar to the fourth and fifth instars.

SECOND-INSTAR NYMPH:

1. About 2.25 mm. long, etc.
2. A kind of inwardly projecting pleural fold along sides of thorax and abdomen.

Sexes indistinguishable externally.

FIRST-INSTAR NYMPH:

1. About 1.85 mm. long, etc.
2. Abdominal fringe of hairs forming ventral air chamber conspicuously extended forward along sides of thorax to the head.

Sexes indistinguishable externally.

ADULTS.

(See, also, page 273.)

For a discussion of the biology of the adults, see pages 177, 194, 195, 197 and 198, of volume XI of the University of Kansas Science Bulletin. There is hardly a living creature of the waters which appears more beautiful and graceful than does *B. margaritacea* Bueno as it calmly glides about in an aquarium jar among branches of *Ceratophyllum*. The pearly luster of the wing covers as seen with the aquarium in a window is beautifully enhanced by the film of air contained underneath them, and the perfect poise of the animal is an expression of grace worthy of note.

In the above-named reference, page 197, it is stated that "the adults appear from early spring to late fall." They are found to appear during every month of the year if one seeks them in their proper habitat. They overwinter as adults only, lay their eggs in the spring and summer, and it may be there are two generations in a season in Kansas. At intervals of every ten days or two weeks they have been collected all winter during the season of 1923-'24. The winter has been a rather unusually cold one.

On January 22 the ice, which was almost twelve inches thick on the pond at the Union Pacific railroad bridge mentioned on page 269, was cut and a few sweeps of the water net made beneath the ice and some distance from the bottom of the pond. Three specimens of *B. margaritacea*, a number of small corixids, and one *Notonecta undulata* were taken. The specimens immediately were brought to the laboratory and placed in an aquarium jar in tap water, which must have been several degrees warmer than that in the pond The water of the pond must have been at 4 degrees Centigrade. The behavior upon this change of habitat was a little unusual. The bugs were not further chilled as they were brought into the laboratory, because it was quite a warm, pleasant day with a temperature of near 45 degrees Fahrenheit. The *Buenoa* acted stunned and very languid, and did not come to the surface for air for about one-half hour. This experience was later duplicated.

The question of just how respiration can take place under the ice and at such temperatures is an interesting one. The bugs most certainly can not get air from the surface. It is true that at 4 degrees Centigrade, the water contains its maximum of oxygen and other gases. But it hardly would seem there could be a sufficient amount for the needs of respiration, although the movements of the water creatures and bugs at such a low temperature is slight and rather languid. In this pond at the time there were some green algæ and *Ceratophyllum*, which no doubt produced some free oxygen bubbles and the water bugs may have used them. But later in February not even green plants were present. Wesenberg-Lund (88) has published a paper, "Uber die Respirations-verhaltnisse bei unter dem Eise uber winternden, luftatmenden Wasserinsekten, besonders der Wasserkafer und Wasser wanzen." It seems that the whole question of respiration beneath the ice is one which has not yet been fully investigated.

The longevity of the adults is yet a question. It would be a difficult matter to determine in nature because of the character of their habitat. They evidently migrate from pond to pond as food supply, water, seasonal differences, and other conditions require. In the laboratory it has been difficult to keep them alive for more than a few weeks, even in winter, and they certainly live as adults through the winter months in the ponds. Repeated efforts may solve the difficulty.

Of their habits of flight the following observations may be of interest. On February 9, 1924, when observing living specimens in the laboratory at night with electric light, two individuals flew out toward the light and fell upon the table showing that they are positively phototropic at times.

Other evidences of phototropism are many. Mr. Robert Guntert says he has taken them many times around the electric lights at night when he was collecting. On March 13, about 8 a. m., one *Buenoa* flew toward the window from an aquarium sitting on the window sill. Sometimes when brought into the laboratory in the evening and spread from the "live bottle" upon a piece of toweling paper to dry, some of them would fly to the windows or electric lights. Most of these incidents happened in March and April, and when the days were moderate in temperature.

April 15 while collecting at Smith's pond several individuals were seen to take flight. Evidently the weather conditions were favorable, for it was a beautiful, quiet morning, and they were migrating. Some were also seen to alight in the pond. Sometimes they had difficulty in getting their wings adjusted properly immediately after alighting, and would kick about and dive in the water rapidly trying to detach themselves from the large air bubbles which hung beneath the hemelytra. They seem to strike the water at a low angle, back upward, and immediately turn over as in the normal swimming position. The pearly-colored hemelytra evidently serve to disguise them from above while in flight and from below while in the water so their enemies may not so easily see them. On taking flight from the water they swim close to the surface for a short time and then suddenly shoot forth from the water at about a thirty-degree angle and take wing. *Notonecta* was observed flying about two weeks earlier. They sometimes climbed out on sticks or other objects near the shore, waited till the hemelytra were dried for a few seconds and then took wing. Other times they would start immediately from the water, fly a short distance, fall back into the water and float along on the surface for a little time dorsum upward and then fly away. *Notonecta* is mentioned here simply in comparison with *Buenoa.*

Of the food habits of *Buenoa,* they are said to feed largely upon *Entomostraca,* and occasionally on other forms, which they hold in the crib formed with the front pairs of legs and pierce with their stylets. About February 9, 1924, while dissecting the abdomen to see if eggs were developing, it was noticed that the stomach contents were green in color. The material was examined under the microscope and gave all the appearances of being the green chlorophyll particles of *Spirogyra,* some of which was contained in the aquarium jar from which the bug was taken. Two or three other individuals within the next two or three days were seen to contain the same material, but not in such quantity as the first one. One bug was found dead in the water still holding a thread of *Spirogyra.* Part of the cells of the thread did not contain their normal amount of chlorophyll, but the beak was not inserted in any of them. It may have just gotten tangled in the thread while in its death struggles. It may be that predacious *Buenoa* also feeds upon algæ as does its relative, the corixid, when other food is not available.

It is worthy of note in connection with the study of the hæmoglobin cells discussed in the following pages that the swimming habits vary. After the bug has been to the surface for air (it seldom remains at the surface more than two or three seconds, which is quite opposite to the facts with *Notonecta* or other water bugs) it makes quick vigorous strokes in order to keep itself beneath the surface. These strokes become less and less vigorous until it may rest in the water in almost perfect equilibrium, sometimes for several minutes. Then it begins slowly to sink and has to use effort to sustain itself. It is usually not long after this till the bug returns to the surface for a fresh air supply. The *Notonecta* and other water insects seem not to be able to remain beneath the surface as long as *Buenoa* and keep their activities the same. Either they swim more vigorously about and come to the surface oftener for air, or they take down a good supply of air and attach themselves, with no activity, to some object on the bottom, or hang at the surface film in constant contact with the atmosphere. Fernald's Applied Entomology, page 184, says the corixids "are able to remain under water without coming up for air for a much longer time than the backswimmers," referring to the Notonectidæ as a group. This has not been found to apply to *Buenoa,* except when the corixids grab hold of something below the surface and remain there motionless. In that case they would not use nearly so much air or oxygen as the *Buenoa* which are gliding about in the water constantly.

In the ponds on a windy day, when the waves are large, *Buenoa* usually swims in the quieter parts where surface contacts are more easily made. They were often seen hovering about the piling of the bridge, where they were collected when they could not be located elsewhere. At the same time *Notonecta* might be found easily about the edges of the pond in the quite rough water.

It has been observed that *Buenoa elegans* is usually found in the shallower parts close to shore instead of out in the open and deep waters, as is so often the case with *Buenoa margaritacea.* They both are found usually in the same pond, and it may be that the smaller species stays closer to shore for protection from the larger one, which may attack it on occasions when they meet.

The *Buenoa,* as a group, appear to be able to swim almost as fast and as well as does *Notonecta,* although it is much smaller. This may be due to their larger development of muscles in the metathorax.

All the Notonectidæ, and especially the *Buenoa,* have a remarkably well developed stream line form, as has been discussed by various writers. This, with the oarlike hind limbs, makes them very well adapted for living in the water.

SOUND DEVICES.

In the University of Kansas Science Bulletin, Volume XI, pages 196, 197, is a description of the sound devices of the male of the species *B. margaritacea* in the following words:

> "Upon attaining the adult stage a sexual dimorphism becomes apparent. Besides the structural differences of the genitalia, the anterior legs of the male possess on the inner faces of the femora and the tibiæ peculiar stridular areas.
>
> "The tibial structure is borne on the inner face of a prominence, which is formed by the elevation of the inner angle or margin of the tibia near its base into a thin but elongate spur. This spur is lacking in the female, and not discovered in the nymphs. (See Pl. XXIV, Figs. 5 and 6.)"

Again on page 195 is this:

> "The males possess stridular areas upon the inner faces of the femora and tibiæ, and also on the sides of the face at the base of the beak. These are shown in the drawings on plate XXIV. The tibial structure is borne on the inner face of a spur near the base of the anterior tibia. When the fore limbs are brought up to the head, it will be seen that the stridular areas of the limbs meet those on the base of the beak. (See the figure on Pl. LIV.) The production of sound is doubtless the purpose of these structures. European workers have recorded notonectids as capable of producing chirping sounds.

Mial quotes Redfern to the effect that *Notonecta* makes a noise like the word 'chew' repeated three times."

In a lecture before the Entomology Club at the University of Kansas in the autumn of 1923 Doctor Hungerford told of hearing *Buenoa* chirping in an aquarium in the laboratory at Douglas Lake, Michigan, the preceding summer, and also described the accompanying behavior of the sexes. His description indicated that a few days before that date *Buenoa* was heard chirping in the laboratory here, but the source of the sound was not then recognized. In the laboratory, one evening in September, peculiar noises were heard coming from a galvanized iron aquarium where some live adults were kept for study. The noise was rather faint, so cautious approach was made and the light turned on to see what was happening. Before the place was reached and before the light was turned on, the noise ceased and did not occur again during the evening. Other lights were on in the laboratory at the time. The noise sounded something like drawing a nail quickly across the teeth of a rubber comb. Nothing unusual was seen in the actions of the bugs swimming in the water, and it was thought to be a mistake until Doctor Hungerford gave his description. It is a common occurrence for them to make considerable noise by butting their heads against the sides of the aquarium, and this might be mistaken for chirping by one who has not become accustomed to them. Constant watching since that time to detect any further sound production or mating has failed.

It should be added that upon careful examination it is found there is also a strong but minute spurlike peg on the outer lateral surface of the anterior coxa which aids, no doubt, in sound production. There are also a number of strong setæ and a chitinous thickening at the distal end and inner lateral surfaces of the anterior femora which are probably used to produce sound by plucking on a chitinous-thickened corner on the sides of the face just below the antennæ. The females possess this last device, also.

So it appears that *Buenoa* has, in the case of the males, three pairs of sound devices and in the female one pair. Beginning at the cephalic end of the body, in the male the first pair is the chitinous thickening and setæ at the distal end and inner lateral surfaces of the front femora, together with the chitinous-thickened sharp corner on the sides of the face just below the antennæ. This is also the one pair for the females. The second pair for the males is the tibial structures borne on the inner face of a prominence near the proximal end of the prothoracic tibia, together with the areas on the lateral faces of the prongs near the base of the beak. The third pair consists of a washboardlike area about midway between the ends on the inner lateral surfaces of the anterior femora, together with a spurlike seta near the base and on the outer lateral surfaces of the anterior coxæ. There are some exceptions to the above rule for some of the *Buenoa,* but it is true in most cases. With all these sound devices it appears they may have a language all their own with quite a variety of sounds and combinations, especially in the case of the males. For an illustration of these devices in their relative positions, see plate LI, figure 4.

ECONOMIC IMPORTANCE.

Fernald in Applied Entomology, page 184, says of the Notonectidæ: "They are carnivorous, feeding on other small insects, but are of little importance." Since the discovery of the hæmoglobin cells in *Buenoa,* they may appear of considerable scientific importance. Their economic importance is not so certain, but they feed upon the small crustacean life of the waters as do some fish, and *Notonecta* has been said to attack small fish. They may be of much more importance to fish culture than is usually thought.

COLLECTING NOTES.

Most of the materials collected for these studies were taken at the Union Pacific railroad bridge mentioned on page 269. It was found to be the most convenient because it was a permanent pond and the bugs could be found there at any time when fresh materials were desired. Most of the studies on *B. margaritacea* were done with fresh material. The piling at the foot of the bridge have cross timbers bolted to them just at the surface of the water. These were found to be very convenient because *Buenoa* usually swims in deep water and well out from the shore. One could walk out on these cross timbers where the water was fifteen or twenty feet deep or stay nearer the bank, as he chose, and still have considerable area of water over which to collect. In this position it was not difficult to see the bugs balancing themselves some distance beneath the surface and to quietly slip the net beneath them and bring them to the surface.

Other collecting was done at Stubb's pond, nearer town, at the brick-plant pool, at Smith's pond east of Lawrence, and in different counties of central Kansas during the month of June, 1923. Sometimes quite a number of *Buenoa* would be taken in the water contained in a cow track in a pool that was drying up. Shallow pools often contained more of them than larger and deeper ones. They seemed to be found during the summer months in the shallow pools where crustacean life was most abundant more than in the deeper ones.

A common water net at the end of a broom handle was used in most cases. The live material was brought into the laboratory in an empty bottle containing a few grass blades, leaves or cellucotton to take up the excess water. If, as is usually well known, one should attempt to bring them to the laboratory in water they would soon drown. When drowned they could, like young chickens caught in a thundershower, be revived by drying out. Often, if any of them were sticking in a little water at the bottom of a bottle, it was found best to empty them out on toweling paper and let them dry till they hopped about vigorously before putting them into the aquarium jar. The eggs and nymphs were sometimes placed directly into the fixing fluid for sectioning or other study when taken from the water. The following fixing fluids were used: for the adults and nymphs: picroformal, picrosulphuric acid and 85 per cent alcohol; for the eggs; picrosulphuric acid, and Perenyi's fluid of chromonitric acid.

TECHNIQUE.

MOUNTING AND DISSECTION.

The technique used in the work of mounting and dissection for the grosser morphological studies was suggested by R. H. Smith in the 1923 September number of the Annals of the Entomological Society of America. To one with no experience the task of carefully dissecting a bug 7 to 7.5 mm., or slightly more than one-fourth inch long, is a rather difficult one. It may be of value to some one to describe here the methods used.

At first the attempt was made to pin down the creature upon parafin in a large dissecting dish, such as was used in the elementary classes in morphology. The pins were too large and in the way of the dissecting needles. They did not hold well and would tear out at the sides and mutilate the specimen. Small "minuten-nadlen" were then tried in a much smaller dish of paraffin and one which did not require nearly so much salt solution. The making of quantities of physiological salt solution every little while was somewhat of a nuisance. It had to be used because the hæmoglobin cells and other tissues would hæmolyze and so cloud the medium in which one was working that nothing could be seen clearly. The red coloring substance of the hæmoglobin cells was responsible for most of the difficulty in keeping a clear field. The "minuten nadlen" did not prove satisfactory, for they would not hold well in the paraffin, and gave the same difficulty of cutting out at the sides of the specimen as did the larger pins. In casting about for some better method the article by Mr. Smith was found.

By this method and for this purpose it has been found better to use a small dissecting dish with a lid to keep the salt solution from evaporating and ruining the specimen when interrupted by class work or other difficulty. A little tin box with a lid, about three inches in diameter and one inch deep, was filled nearly half full with melted paraffin. This was allowed to cool. The bug was then held in one hand with a small pair of tweezers by the legs or otherwise, depending upon the position desired for placing and the ease of holding. In the other hand was held a piece of wire of the size of bailing wire or a little larger. The wire was placed in a gas flame till hot and then used to melt a small area in the smooth surface of the paraffin near the center of the dish. Immediately the bug was placed in the melted area in the position desired. The paraffin hardened quickly as it cooled and held the bug firmly in the desired position. If a film of water happened to be clinging to the bug, a second application of the hot wire around the bug was sometimes necessary to make the paraffin hold well. A large needle might just as well have been used to melt the paraffin. To hasten the cooling and hardening of the paraffin and to prevent cooking of the more delicate tissues the physiological salt solution was poured immediately into the dish, but not directly on the bug, for sometimes it would wash away the melted paraffin around it. At this stage all was ready for the dissection to begin.

Instead of paraffin in the dissecting vessel, beeswax and shoemaker's wax were also tried. Beeswax was almost as good as paraffin but a little soft. Shoemaker's wax being very dark in some cases was an advantage because of the contrast with the insect tissues. Usually it remained too soft, or the heat from the electric light used was sufficient to soften it so that it did not hold the insect satisfactorily.

A medium sized sewing needle mounted in a handle, heated in a gas flame, flattened on an anvil, and sharpened with a fine carborundum or razor hone under the binocular to a delicate arrow-shaped point, was used to open the insect. The opening was done by piercing the body integument and then cutting outward against the paraffin. Otherwise the internal tissues would be crushed and mashed out of place. The chitinous body wall of *Buenoa* is quite thick in places considering the size of its body. After a cut was made entirely around the body and outward against the paraffin the top section could be lifted off and the interior examined in its natural position. In dissecting the tougher portions it was found sometimes to be of advantage, in getting the insect thoroughly fastened down in the paraffin, to clip off the wings close to the thorax, or in other cases to clip off the legs.

The scalpel made from a needle just described; two or three dissecting needles made of "minuten nadlen," mounted in handles and bent at the tip or sharpened to suit the worker; one or two dissecting needles from sewing needles of the medium sizes, mounted and sharpened; two ink droppers or pipettes, one with a large opening and the other with a smaller one, to remove bits of tissue suspended in salt solution for microscopic examinations; a few slides and cover slips; a large binocular microscope with an oil immersion lens attached; and a smaller binocular, were the tools used in this study. Also a projection microscope was sometimes used.

TRACHEAL TECHNIQUE.

The hæmoglobin cells studied are closely associated with the tracheal system, and it was therefore necessary to trace out something of the structure of this system. A study of the tracheal system was also necessary to aid the findings of the other morphological studies. For this purpose it was found to be much better to use fresh specimens in which the tracheæ were yet filled with air, giving them a silvery white lustre and making them visible. It was almost impossible to distinguish tracheæ from other tissue when once filled with water. One could not work long with the same specimen till the larger tracheæ would become so filled. This was especially true with those of the thorax. Some of the suspected connections could not be clearly traced, and it was decided to try a process of injection of the tracheæ described by August Krogh (45), of Copenhagen University, in 1917.

For an injection fluid he used a mixture of paraffin, beeswax, colophonium and turpentine, stained as deeply as possible with alkanna. It was difficult to get any alkanna, and that which was finally secured may not have been of much value. The process described by Krogh was repeatedly tried with *Buenoa* and found unsuccessful.

The substances penetrated the other tissues as well as the tracheæ and made the tracheæ invisible. The process may be good for the larger insects.

Glycerin agar melted and colored deeply with finely powdered carmine was tried instead of the mixture above described by Krogh. It worked very poorly. The process of attempted injection used for this was the same as is given on page 285 except that the colored agar was placed in the large bottle and cooled till it hardened.

The bugs, inclosed in a wire-screen cage so they would not sink, were placed in a bottle on top of the solid agar. The air was exhausted and the bottle containing the colored agar and the bugs was immersed in a hot-water bath until the agar melted and the bugs sank into it. The air was then slowly readmitted to force the liquid into the tracheæ. With the reduced air pressure the substance would boil at a very low temperature soon after it melted and so disrupt the tissues. But the process did not work well even when boiling was prevented.

Krogh also suggested using colored turpentine instead of the above mixture in the case of animals with closely intact spiracles. This was tried with considerable success, but no substance was found which would satisfactorily color the turpentine so that the tracheæ would stand out in strong contrast to the other tissues. Eosin, powdered carmine, picric acid, methylene blue, and borax carmine solution were used in attempting to color the turpentine. At best only a weak stain, which under the binocular was greatly diluted, was secured with any of them. A substance of a lipoid nature was necessary according to Krogh in order to penetrate the tracheæ. Turpentine was such, but was not strongly enough colored.

It was decided to try Grenacher's borax carmine, a substance which has a very dark red color. It was felt that this surely would give the desired contrast if it could be made to penetrate deeply enough. It penetrated very nicely to the remote tips of the tracheæ, giving a bright-red color under the binocular in strong contrast to the surrounding tissues. A large part of the sketches of the tracheal system of *Buenoa* as figured in the accompanying plates were drawn with the aid of this injection material. It can no doubt be as successfully used with other minute or small insects. A difficulty arises when an attempt is made to use it with the larger insects or larvæ. An injection was made of a nearly mature tipulid larvæ, but it was found that the fluid would flow out from the larger tracheæ when the insect was handled.

The article by Krogh may not be readily available to the reader, as it was not in our case, so there is given here something of a repetition of the device used by him, together with the modifications as used in this laboratory. A quantity of the injection mixture, Grenacher's borax carmine, was kept in a wide-mouthed bottle of about 250 cc. capacity with a ground tubulated stopper. If the ground tubulated stopper was not available, a large rubber stopper with a piece of glass tubing inserted was used. The neck of the bottle was reënforced with adhesive tape to prevent its being easily broken. The diameter of the rubber stopper was increased with the same material to prevent its being pushed too far into the bottle by the air pressure. The animals to be injected were removed from the aquarium jar to a piece of toweling paper till the film of water was removed from them. They were then deeply narcotized by dropping them into a large bottle with a wad of paper or other material saturated with a few drops of ether and replacing the stopper till they were quiet for a moment. This was done to make them immobile and render ineffective the mechanism for closing the spiracles or tracheæ.

A number of the bugs were usually so treated at the same time, and one kept for a control to see that all were not killed with the ether. The others were then placed in a wire-screen cage in the bottle with the injection mixture, but kept above it till after the air was exhausted. The stopper was then put in place and the bottle connected by means of heavy rubber tubing to an air pump or aspirator. Previously the aspirator was fastened to the faucet at the sink, one screw clip closed and the other screw clip opened. The water was then turned on at the faucet and the air exhausted from the bottle containing the bugs. After fifteen or twenty minutes the exhaustion of the air was usually sufficient, for a pretty good vacuum could be secured by such means. The cage containing the bugs was then turned over by turning the bottle, so that the bugs were immersed in the liquid; one screw clip was closed, and the second screw clip was slowly opened till air bubbled through the wash bottle used to indicate the rate of release of air into the vacuum. This was so regulated that the air bubbled in quite slowly. A thermometer tube or other tube with a bore of 0.1 mm. or less was used to aid in regulating the air supply as was suggested by Krogh. The joining was made with heavy rubber tubing and all connections were made airtight with a little vaseline.

The most important point in the whole technique was the slow increase of the pressure which secured a complete filling of the tracheal system. After about half an hour the second clip was opened a little, care being taken that the injection should never be completed in much less than an hour. When the pressure had risen to normal the bottle was disconnected and opened, and the bugs taken out and mounted in the paraffin dissecting dish previously described.

CELLULAR TECHNIQUE

The technique used for the cellular and more minute structures was the same as is ordinarily used for such work. The tissues were fixed and embedded in paraffin, sectioned, mounted and studied under low-, high- and oil-immersion lenses with a binocular compound Bausch-Lomb microscope equipped with an Abbe condenser. Attempt was made to use the projection microscope, but the lighting was insufficient under high magnification.

EXTERNAL MORPHOLOGY.

Concerning the external morphology of the Notonectidæ, and especially about the genus *Buenoa,* little seems to have been written or figured. From the viewpoint of pure morphological interest and from a consideration of the possibility of aiding in determining the phylogenetic or other relations of the order Hemiptera-Heteroptera, a thorough study of the morphology of *Buenoa* and the other genera of the Notonectidæ might be of considerable value. No pretense of such a thorough study is made in this paper. What is given may help further study. The terminology used is intended to be in accordance with that of the latest authorities. However, Crampton, 1916, wrote that the Hemiptera-Heteroptera were composed of four typical groups or suborders, and he called the notonectid group the Euhemiptera or true Hemiptera. He said that, "The true Hemiptera are so highly specialized that they are of no great interest from the standpoint of the study of phylogeny; but the Homoptera give some valuable hints as to the relationships of certain of the higher forms." (Ent. News, XXVII: 301.)

Ashton, 1837, in a discussion of the wings of Hemiptera, figured and described the union of the wings of *Notonecta.* Berlese, 1909, in "Gli Insetti," in that part of the volume dealing with external morphology, figured the abdomen and genitalia of *Notonecta glauca.* Hoppe, 1911, in "Die Atmung von *Notonecta glauca,*" gave some descriptions and a few figures of both adults and nymphs. Rich, 1918, in describing the respiratory organs of a notonectid in South Africa, which he was not able to identify, gave two figures of the abdomen. Hungerford, 1919, in the University of Kansas Science Bulletin, gives a number of plates showing something of the adults and nymphs of the three genera, *Notonecta, Buenoa,* and *Plea.* Other figures have since been given of *B. macrotibialis* and *B. limnocastoris.*

HEAD.

The head of *Buenoa* appears as in Plates XLIV and XLIX. The eyes are quite large in comparison with the size of the head and rather close together. They approach closest at the notocephalic margins of synthlipsis. In the species like *B. margaritacea,* they form, with the lines of the prothorax, a smooth contour as seen from a dorsal view. In those species more of the type of *B. elegans* they project laterally or appear to protrude beyond the lines of the prothorax when viewed dorsally. The ommatidia are quite regularly hexagonal. The epicranium or sclerite between the eyes is narrow and extends from near the ventral separation of the mesal or inner margins of the compound eyes to the caudal and dorsal part of the head, and seems to form the dorsal margin of the occipital foramen. The genæ form the more lateral and ventral parts of the occipital foramen. The frons is not distinctly separate from the epicranium in the adults, but appears more so in the nymphs. The clypeus seems to be fused with the frons. The postgenæ are small and linear. The genæ are rather long and have a part beneath what appears to be the beak. The trochantin of the mandible or basimandibula is rectangular and has the angle in front of the antennæ large and sharp, and is evidently used to produce sound by plucking with the front femur as described on page 278. The labrum is a small flap distinctly seen below the clypeus, and is covered with many fine setæ which makes it appear like a moustache. (See Pl. LI, Fig. 4.) The labium with four distinct segments has a ventral groove in which are contained the stylets consisting of a pair of mandibles and a pair of maxillæ. The proximal segment in the females is considerably enlarged sternally. The part of the head to which it is attached is correspondingly large, probably to better accommodate the larger salivary glands that are present in the males. The proximal segment in the males is rather inconspicuous. The second segment in the males is prolonged laterally into prongs. On the lateral faces of these prongs are washboardlike areas used in the production of sound. Along the median line of these areas is usually a row of very small but darkly chitinized toothlike setæ which evidently aid in the process. The third and fourth segments of the beak are longer, and all are open ventrally with a narrow groove. Near the base of the beak and beneath the labrum the mandibles are seen. They often protrude at the end of the beak in mounted specimens, or live adults held under the binocular can be seen to make them protrude quite often. The mandibles and maxillæ are rather loosely held together in the sheath of the labium. The mandibles have a row of serrate recurrent spines on the lateral surfaces at the tip. The mandibles and maxillæ form the tube through which the juicy foods are taken. Time has not been taken to work out their exact relations and form.

THORAX.

PROTHORAX. The prothorax appears to consist of an almost continuous segmental ring of chitin, longer in width laterally than in length in the caudo-cephalic direction. Some evidence of sutures is seen at the ventral parts to mark off the sternite and the antecoxal pieces, but the pleurites appear to have wholly fused with the surrounding sclerites.

MESOTHORAX. The mesothorax is more complicated than the prothorax because it bears the front wings or hemelytra. The dorsum of the mesothorax extends well cephalad under the dorsum of the prothorax and appears to be divided at the anterior margin into pairs of sclerites by three sutures. One extends caudad and dorsad on either side from the anterior and caudo-lateral margin. (See Pl. XLIX, Fig. 2, dotted lines.) These sutures mark the dividing point of two sets of large muscles in the mesothorax. The sternum appears as a broad central plate ventrally between the mesothoracic legs. A suture marks off the mesal margin of the antecoxal piece as shown in the figures. (Pl. XLIX, Fig. 1.) The pleurites appear as shown in figure 3, plate L.

An interesting pair of sclerites, which appear at first to be antecoxal pieces of the metathoracic legs, are two large ones called by Rich, 1918, extensions of the mesothoracic scutellum. These appear to arise from an episternite of the mesothorax, and extend caudad and ventrad, covering almost entirely the metathoracic coxæ and a large part of the metasternum. They cover and help with their fringes of setaceous hairs to form the ventral air channels to the thoracic spiracles. This fringe of hairs is on the mesal and caudal edges only in the adults, but appears also on the outer lateral edges in the nymphs, as is shown for the fifth-instar nymphs in plate LVII, figure 1 and 2.

The sclerites about the base of the front wing have not been worked out thoroughly. The caudal margin of the mesothorax is joined broadly and firmly to the anterior margin of the metathorax.

SPIRACLE. On the cephalic margin of the mesothorax, laterally and ventrally beneath the caudal margins of the prothorax, and in the more or less nonchitinous membrane connecting the prothoracic and mesothoracic segments, are the spiracles. They exist simply as a rather large opening in the membrane, and seem not to have any sclerites about them such as the peritremes of the abdominal segments. The insect seems to be able to close them in case of need by simply pulling the prothorax and mesothorax closer together, so that the posterior and anterior margins respectively telescope one another more closely. These spiracles appear to be the largest and supply the biggest and most remarkable array of tracheæ in the whole body. This bunch of tracheæ is no doubt so developed because it supplies the air to the wing muscles. (Pl. XLIV, *TP.*)

METATHORAX. The metathorax is the largest segment of the entire body. This must be because it contains the muscles of the hind wings most used in flight, and also those of the swimming legs which in the water are almost in constant use. The metathorax of *Buenoa* is relatively much larger and projects further caudad on the dorsal side than it does in the *Notonecta.* This may be due to the more constant use of the swimming muscles in *Buenoa* than in *Notonecta.*

The exterior surface of the metathorax appears smoother than that of the mesothorax. The metathoracic tergite is divided on the dorsal median line by an internal projection or apodeme. This is the largest sclerite of the body. The sclerites about the base of the wing are rather small and undifferentiated. The pleurites appear large and distinct. (See Pl. L, Figs. 3 and 4.) The metasternum is a large ventral plate and possesses a large spinelike projection extending caudad on the mesal line between the coxæ of the hind legs. (See Pl. XLIV and XLIX, Fig. 1.)

At the cephalic margin and from the dorsal surface there extends internally and ventrally, about two-thirds the diameter of the body, a large apodeme which apparently serves as a fastening for the muscles supplying the wings of both thoracic segments. This apodeme pushes the dorsal aorta and œsophagus to a quite ventral position in this region of the body. Another similar apodeme at the caudal margin of the metathorax does likewise, except that it does not extend so far ventrally, and extends cephalad and laterad at the same angle as is formed by the caudo-lateral margins of the metathorax to which it is also joined. (See Pl. XLIV, *IC* and *Ic*.) Prominent ventral apodemes are also present which somewhat surround the ventral muscles leading to the legs. (See Pl. XLVI.)

The spiracle, with a somewhat hidden chitinous opening, is just beneath the base of the wing. (See Pl. L, Figs. 3 and 4.)

WINGS.

The wings are figured in plate L, figures 1 and 2. For the fifth-instar nymphs, see plate LVII. Both wings are quite transparent, but the proximal area of the fore wing is more translucent. The wing venation is much reduced and quite difficult to determine accurately. The labeling given is approximate.

The fore wing has two unique devices for fastening to the body when not in use. Such or similar devices have been figured for *Notonecta* by Ashton, 1837. The snaplike device at *L* in figure 1, plate L, fits into a sort of hook at *L* in figure 3 of the same plate. The snaplike device at *B* in the figure fits into another groove or hook at the median dorsal line of the body. The membranous part of the wing at the apex is quite coneshaped in life. In some species this part of the wing may aid in breaking the surface film when the insect comes to the surface of the water for air. In most of the *Buenoa* studied it does not do so. The film is usually broken by the abdominal hairs.

The hind wing is quite delicate and beautifully iridescent. It is folded in two folds beneath the hemelytra or fore wing. The veins of the region near the front margin are the only ones that are distinctly visible unless the wing is mounted dry. The mounting of this wing is a rather difficult matter if one desires a perfect specimen.

LEGS

The legs of the thorax have each the same number of segments but are variously modified to suit the purposes for which they are adapted. All have the common segments, coxa, trochanter, femur tibia, two tarsal segments, and two tarsal claws at the end of the distal tarsal segment. (See Pl. XLIV.)

The legs of the prothorax and the mesothorax are much alike in form, but those of the mesothorax have somewhat longer and more slender segments than those of the prothorax. Many setaceous spines are so arranged that when the legs are flexed they form a crib in which to catch and hold prey. These spines may also aid in forming the ventral air chamber. They are lined in definite rows, especially on the tibiæ and femora. (See Pls. XLIV and LI, Fig. 6.) On the front legs are the modifications for the production of sound described on page 278 and again on page 287. (See Pl. LI, Fig. 4.) In this figure corresponding numbers are given to those parts which seem to work together in the production of sound. Their relative positions are the bases for the conclusions. The coxæ of the two front pairs of legs are quite long and ventrally distinctly visible. The trochanter is rather short and V-shaped, with a number of setaceous hairs or spines on the apical surfaces which help form the ventral air chamber of the thorax.

The hind legs are especially modified for swimming, as they have a fringe of setaceous hairs on each side of the segments including the femur to the tarsal claws. The fringe on the femur is not strongly evident but it is well developed on the tibia and tarsal segments. The whole leg bears a strong resemblance to an oar. In the first-instar nymph the fringe is found only on the tarsal segment. The tarsal claws of the adult are of the same length at the tip of the tarsus as the swimming fringe and are much reduced and inconspicuous. In the nymphs they are much more conspicuous.

THE ABDOMEN.

GENERAL. Eleven segments are found in the abdomen. The first two caudad of the thorax are not distinctly separated, but are firmly joined together and to the caudal margin of the metathorax so far as the tergites and sternites are concerned. The pleurites are somewhat more distinct and more easily separated. Each segment from the second one to the seventh, inclusive, is made up of a single tergite, two pairs of pleurites, and a single sternite. (See Pl. L, Fig. 4; and Pl. XLIX, Fig. 1.) In the seventh segment there is apparently an extra pleurite on each side, making three pairs of pleurites for this segment. (See Pl. LV, Figs. 4, 5 and 8; and Pl. LII, Figs. 8, 9 and 12.) Caudad of that the pleurites are simply chitinous membranes. The genital segments are left for later description.

HAIRY FRINGE. Near the juncture between the two pleurites on either side of each segment, and extending cephalad from the seventh segment to the thorax, is a row of long, blackish, setaceous, aquifuge hairs which fold closely parallel to each other and mesad, forming the abdominal air channels. The tips of these hairs meet those from the opposite side in the cephalic part of the abdomen. Near the caudal tip they meet with shorter hairs on the ventral median carina. (See Pl. LII, Fig. 12, for the male; and Pl. LV, Fig. 8, for the female.) They are also figured on other plates, but are not usually drawn as long as they appear in life, because if they were one would not be able to distinguish other parts in the drawings. Under magnification these hairs are found to be nearly flat. Together with the surface tension of the air bubble which they hold they are able to keep water out of the spiracles. The surfaces of the air chambers also seem to be aquifuge. At the caudal tip of the abdomen this air chamber is divided by the median carina into two separate parts, but these parts unite shortly cephalad and continue as one to the head on the ventral surface of the body.

SEVENTH STERNITE. The seventh abdominal sternite in the females is projected caudally into a sharp V-shaped point on the mesal line. The function in oviposition of this sclerite has been described on page 271. It also serves as a ventral shield to the genital parts at the tip of the abdomen, and may aid with the abdominal hairs in breaking the surface film when the animal comes to the surface for air. (See Pls. XLIX, L, LV and LVII.)

FIFTH STERNITE. The fifth abdominal sternite in the adult is especially large. It projects forward on the median ventral line until it almost divides the fourth sternite in two halves. (See Pl. XLIX, Fig. 1; and Pl. L, Fig. 4.)

FOURTH STERNITE AREA. Just mesad and caudad of the fourth abdominal spiracle, and on the fourth sternite, is a smooth, rather glandular-appearing area. It is quite noticeable ventrally in both males and females when the fringe of hairs forming the ventral air chamber is turned aside. Examined under high power it is found that the smooth surface is due to the fact that there are no setæ on the sclerite at that place. The entire inner surface of the air chamber next the body, except the peritremes around the spiracles and the area just mentioned, is covered with quite an even distribution of minute setæ. They seem to aid in making the surface aquifuge. Just what function this smooth area may have is not known. It was closely examined for glandular openings, but none were found.

FIRST TO THIRD STERNITES. It has been written that the first and second sternites were closely united. Berlese figures those for *Notonecta glauca.* He shows the first sternite to have internal projections or apodemes, but otherwise to be quite small. *Buenoa* appears to have the first sternite quite large, extending forward and laterally to a point near the middle of the methathorax. Immediately on each side of the median ventral line, and projecting internally and caudally from the first sternite, are two darkly chitinized and quite long apodemes. The caudal extremities of these processes extend into the third or fourth abdominal segments. Muscles which appear to aid the hind legs in swimming are attached to them. The second sternite, closely united to the first, is a narrow sclerite immediately caudad of the first, and extends to the large, second abdominal spiracle at its anterior lateral corners. The third sternite, immediately caudad of this, is narrow and is the first anterior one of the venter to be colored darkly.

SPIRACLES. The spiracles are at the lateral edges of the sternites. All are quite large compared with those of *Notonecta*. Each one, except the first and eighth, are distinctly marked by the white color of the peritremes, in strong contrast to the blackish color of the sclerites which surround them. Those of the second and fifth segments are the largest. The first abdominal spiracle is so far forward that it appears superficially to be at the middle of the metathorax. (See Pl. L, Fig. 3; and Pl. XLIV.) The eighth one does not appear except in the nymphs. (See Pl. LVII, Figs. 1-4.) In the adult it has atrophied because of the retraction of the segments caudad of the seventh. It may be rather nonfunctional in the nymphs.

SWIMMING HAIRS. In both male and female a row of long, silky, setaceous, free-swimming hairs is found near the junction of the seventh tergite with the pleurites. This row usually extends cephalad on to the same part of the sixth segment. (See Pl. LII, LV, and LVII.) The function of these hairs seems to be to aid in balancing the bug when at the surface film for air. When it is in that position these hairs appear to attach themselves to the film, and serve as anchors. They also may help some in swimming, serving somewhat as rudders or like the tail fins of a fish.

DORSAL SPINE. In the adult male, on the sinistro-caudal margin of the seventh tergite, is a long and often quite black spine. The approximate parts of the tergite are so modified as usually to make the whole segment somewhat unsymmetrical. A corresponding spine or "strigillum" is found on the males of the corixids, but in that family the adjoining sclerites are much more unsymmetrical. This structure seems to be another indication of some relationship between the

Notonectidæ and the Corixidæ. Whether a similar spine is ever found in *Notonecta*, or the other genera of that family, has not been determined. The purpose of this spine has not yet been learned. It is supposed that it is of some use in mating. It appears to have nothing to do with holding the wings in position or other such use, and is not found in the females. The males of every species of *Buenoa* studied possess it. (See Pl. LII, Figs. 9 and 11; and Pls. LIII and LIV.)

HEART AREA. On the dorsal median line of the second to the fifth abdominal tergites, inclusive, is a very thinly-chitinized membranous area. This area almost divides the tergites of these segments into two halves. If a live adult bug is held in position with the dorsum upward under a high-power binocular regular pulsating movements can be seen. These movements are caused by the dorsal vessel, or heart. An enlarged portion, and probably the most functional part of the heart, is located there. The membranous portions of the tergites there allow more expansion and freer movements of that organ. (See Pls. XLIV and XLIX, Fig 2.)

EXTERNAL GLAND OPENINGS OF THE MALE. In some species of *Buenoa*, *B. margaritacea* and those of similar size and appearance, the males possess near what seems to be the junction of the pleurites of the first and second abdominal segments, on each side, a pair of small, blackish, glandular-appearing spots. These spots are also underneath the edges of the hemelytra when closed and beneath the outer lateral edges of the large shieldlike plates over the bases of the metathoracic coxæ, but are still plainly visible from the exterior In one or two species, probably not yet described, similar spots are found which are not black. The spots are distinctly visible to the naked eye, vary somewhat in size, but are about one-half millimeter in diameter. When viewed vertically with magnification they have somewhat the appearance of a rather large, thick doughnut with a small hole in the center. The hole is probably the opening for the discharge of some fluid upon the surface of the body from what appears to be a gland underneath. The colored part at the surface of the body around the opening consists of many small, very darkly colored or chitinized cells. Most of the cells are very perfectly hexagonal in form. The thinly membranous chitin surrounding the organ enables one to easily pluck it out. The outer colored portion is quite hard and projects a little way above the surface. When plucked out a string of tissue clings to it somewhat as shown in figure 1, plate LI. This distinctly visible glandular opening, visible although somewhat covered at times with translucent wings, may prove of considerable taxonomic value aside from its morphological interest. The function is not known. It may be a scent gland for the attraction of the females, or it may provide the oily, aquifuge substance covering the interior of the ventral air chamber. (See Pl. L, Fig. 3*G;* and Pl. LI, Figs. 1 and 2.)

The suggestion may occur that this structure is a modified spiracle, but all the spiracles have been accounted for, one each in the mesothorax and metathorax and the first eight segments of the abdomen. Sectioning has not yet been successful enough to give any further information about it.

GENITAL SEGMENTS.

TERGITES. The eighth abdominal tergite is the last one which is very distinctly seen from a dorsal position. The others may all be seen in the female if properly extruded. The eighth tergite is very similar in shape and appearance in both males and females, but in the females it more closely incloses the tip of the abdomen. At the caudo-lateral edges it is prolonged somewhat into a sort of oval flap or projection which covers the more caudal segments. This projection is called by Berlese in *Notonecta glauca* the procercus. The outer surface of these projections is covered by one or two patches of small setæ. (See Pls. LII and LV.)

The ninth tergite in the female has on the median dorsal line a cluster of setaceous hairs projecting through the opening of the eighth tergite. To its anterior projections and at the lateral margins are attached the ovipositors. (See Pl. LV.) In the males the ninth tergite is almost a nonentity. It is a thin membranous piece projecting under the eighth tergite, and almost entirely invisible from the exterior. (Pl. LII.) The genital claspers apparently arise from it.

The tenth tergite is distinctly visible in both males and females. In the male it is covered dorsally with a fine, silky coat of setæ, and appears to stand up dorsally at an angle over the anal opening. In the female its outer surface is comparatively smooth, and the styli or acrostyli, so named by Berlese, seem to arise from its ventral margin.

The eleventh tergite in the female shows distinctly as a soft chitinous point at the tip of the abdomen and adjacent caudally to the tenth. It seems to be directly over the anal opening ventrally near the junction of the tenth and eleventh segments. In the male it is almost invisible, but appears as a slight projection at the tip and beneath the tenth tergite, above the anal opening. (See Pls. LII and LV.)

STERNITES. The sternite of the eighth abdominal segment in the female is retracted within the body and dorsad of the seventh sternite. Its anterior end is opposite the anterior end of the seventh sternite. It seems to be divided into two halves, connected by a thin, almost nonchitinized membrane. (See *8* in figures of Pl. LV.) It is certain this sclerite, as shown in the figures, represents the eighth sternite, because the tracheæ leading to the nonfunctional eighth spiracle joins it at the outer lateral margin, a position homologous with the position of the spiracles in the more anterior segments. In the male the eighth abdominal sternite extends caudad from the hind margin of the seventh sternite beneath and inclosing the genital bulb, or ninth sternite, in the position analogous to that of the seventh sternite in the female.

The ninth sternite in the female seems to consist of two chitinous rods connected by an almost nonchitinous membrane and inclosed by the eighth sternite as shown at *9* in figures of plate LII. These two rodlike structures extend cephalad to the anterior margin of the eighth and seventh sternites. At the caudal end of those rods, and between them and the lateral prolongations of the ninth tergite, the ovipositors are attached. In the male the ninth sternite is very distinct, and is commonly called the genital bulb, since it forms the ventral inclosure for the genital claspers and œdagus. Below it ventrally is the eighth sternite, caudally tipped like the seventh sternite in the female. (See Pls. LII and LV.)

The tenth and eleventh sternites seem to be very weakly represented by any structure or sclerite in either male or female. Possibly the tenth sternite is represented by a small chitinous piece between and beneath the genital claspers in the male and known, in the Homoptera at least, as the connective. The development in the fifth-instar nymph seems to indicate this. In other cases the sternites are represented, if at all, by very small and thinly chitinized membranous parts. In the tenth and eleventh segments of the female they apparently are crowded to the minimum by the gonapophyses, which occupy most of the ventral position. In the male eleventh the same thinly chitinized part must be all that remains. (See Pls. LII, LV and XLIV.)

In the male the anal opening is above the œdagus and near the extremity of the tenth tergite on the ventral side. In the female it is in a similar position between the base of the eleventh segment and the styli. (See Pls. XLIV, XLV, LII and LV.)

GONAPOPHYSES.

ADULT. Folsom, 1922, writes that "Most authorities have found that the gonapophyses belong to the segmental series, or pairs, appendages—are homadynamous with limbs—and pertain commonly to abdominal segments eight, nine and ten; though there are different views in regard to this." The results of this study seem to show the ovipositor proper to be connected with the ninth segment of the abdomen. Two other ventral pairs of structures having the appearances of being gonapophyses are caudad of the ovipositor. These are figured as *St* and *Sty* in plates XLIV, XLV, L and LV. The ovpositors are figured in the same plates and plate LVI as *Ovip.* The pair of sclerites marked *St* terminate in two minute sharp points at the caudal tip, seem to be divided but closely united along the median ventral line, and appear in the position of a sternite on the tenth segment. Because of the delicate membranous nature of the cephalic ends of these sclerites it is difficult to be certain whether or not they may not belong to the ninth segment. The third and last pair of what must be gonapophyses (for cerci are present only in the more generalized insects) are rather large, black-tipped organs, marked in the plates as *Sty.* Berlese likely would call them acrostyli, or acrocerci, and the ones immediately cephalad of them the mesostyli or mesocerci. They are covered with many fine bristlelike setæ. They appear in the adult to be attached also to the tenth segment. They are used in oviposition, as has been described. The opening of the oviduct is between and at the cephalic end of the pair of sclerites, marked *St*, which are rather nonfunctional and rudimentary.

In the male adult the gonapophyses seem to be represented only by the genital claspers and the œdagus. The claspers, which are unsymmetrical, the left or sinistral one being larger and hooked at the tip, are attached to the ninth segment, as are the ovipositors. Also, they are closely bound by tough tissue to the connective, which must be the sternite of the tenth segment. From the caudal side of the connective and beneath it the œdagus arises and extends caudad. It consists of a series of ringlike segments or rings forming a tube opening at the caudal tip of the body. The claspers account for one pair of the gonapophyses. The œdagus accounts for another. If there are any parts which represent a third one of the gonapophyses in the adult male they have not been discovered positively.

From the studies of the adults there are two pairs of gonapophyses attached to the ninth segment and one pair attached to the tenth. At least the structures indicate that, and authorities have found some variation from the rule of eight, nine and ten.

DEVELOPMENTAL STUDIES.

EXTERNAL. Some attempt was made to trace the development of the genitalia in the instars. Externally no marked change takes place in the development of the nymphs, so far as the genitalia are concerned, except in the ventral sclerites at the tip of the abdomen. The seventh abdominal sternite shows the most marked changes in development, and by observing its shape and size the males and females may be distinguished as early as the third instar. In the first and second instars it is practically impossible to distinguish any difference, and it is quite difficult sometimes in the third instar. Beginning with the fourth instar, however, it is an easy matter to distinguish the sexes. The other sclerites caudad of the seventh sternite also show considerable development in the fourth and fifth instars. It is in these instars that the eighth abdominal spiracle is especially visible. (See Pl. LVII.) At the tip of the abdomen in all the instars is a rather large, flaplike sclerite ventrad of the anal opening, called by Hoppe, 1912, the analkonus It must represent the sternite of the eleventh segment. This structure entirely disappears at the end of the fifth instar. (See Pl. LVII, Fig. 3, *A*.)

In the female the seventh sternite is prolonged caudally, while in the male it is more rectangular. The sclerites of the sternal side of the ninth, tenth and eleventh segments, including the developing gonapophyses, also seem to be represented. The styli, *Sty,* are distinctly visible as little darkened projections. The pair just cephalad of these is represented by a mere point, as at *e* in plate LVII, figure 4. The ovipositors seem to be represented by small, rectangular areas, *d,* in figure 4, and the sternites of the eighth, ninth and the tenth segments by *a, c, e,* respectively.

In the male the developing genitalia have no external counterpart in the nymphs, so far as could be seen. Only the sternites have corresponding sclerites represented. (See 9, 10, *A*, in Fig. 3, Pl. LVII.)

The caudal part of the tip of the abdomen in both males and females, on the dorsal surface, shows little if any indication of segmental arrangement, but is covered with patches of setæ as in the adult. These setæ probably aid the bug in keeping its equilibrium in the water and in giving it more floating ability.

INTERNAL. An attempt to dissect out the developing genitalia and study their forms was made. This was done with the expectation that it might throw some light on the structures as found in the adult. Since the parts were soft, and for the most part not held intact by coverings of chitin, it was a rather difficult undertaking. Some evidence was obtained from the fifth-instar nymphs and a mere trifle from the fourth. In the earlier stages nothing could be distinguished since the parts were not clearly differentiated. The materials were such as had been preserved in 85 per cent alcohol. Some had been fixed in picrosulphuric acid.

For the female the parts as dissected out are represented in figure 6, plate LVII, for the fifth instar. The fourth instar appeared much the same except that it was smaller. The origins of the parts could not be distinguished clearly, but seemed to bear out the studies and conclusions on the adult.

In the study of the fourth instar very little could be distinguished of the developing genitalia of the male. The parts were very much all one mass. With the fifth instar some detail was available. Figure 5, plate LVII, represents what was found. Here it is seen that the œdagus appears bifurcate at the tip, showing its development from a pair of gonapophyses, as has been found in other studies. The pair of gonapophyses not seen in the adult seems to be present here as at *A*, figure 5. It must fuse with the pair forming the œdagus. The pair representing the genital claspers in development is quite evident, as at *c*, figure 5.

The locations of the gonapophyses were the same as were found in the adults. It is desirable that further and quite careful studies be made to verify these results.

COMPARATIVE STUDIES.

OVIPOSITORS. A brief study of the ovipositors, to see if the number and position of the teethlike setæ might be of specific value, has been made and is appended here. To get absolutely reliable data these studies would have to be extended over a much larger number of individuals. Not more than three or four individuals were used from any one of the places named, and in some cases just one, because of the lack of sufficient material.

The number of teeth on the cutting edge of the ovipositor was taken for one count. The number of teeth not on the regular cutting edge of the ovipositor, but situated on the sides and out of alignment, as at *A* in plate LVI, was taken as another count. The counts were made under transmitted light with oil immersion or high power magnification.

Locality label and specific name.	*Number on edge.*	*Number on side.*	*Number of specimens examined.*
Bryant's Bog Douglas Lake, Michigan (*B. macrotibialis* paratype specimen)	40 and 41	—	1
Douglas county, Kansas (*B. margaritacea*)...........	33 and 35	2 or 3	4
Chile, South America (Undetermined)	50 and 48	4	1
Bryant's Bog, Douglas lake, Michigan (Undetermined),	40 and 38	4	2
Benson, Minn. (Undetermined)	37	none	3
Stubb's pond, Douglas county, Kansas (Undetermined),	37	2 or 3	3
Superstition mountains, Arizona (Undetermined) ...	35	2 or 3	1
Sedge Point pool, Douglas lake, Michigan (Undetermined)	30 and 31	2 or 3	2

It will be seen that the number of teeth on the cutting edge of the ovipositor varies from 30 to 50, and that there is some variation in the number not on the cutting edge. There are also other characters of the ovipositors, which may be taken as indicating specific value. (See Pl. LVI.)

Genital Claspers and Spines. A little more detailed and extensive study of the genital claspers and the spine at the caudo-sinistral margin of the seventh tergite was made than of the ovipositors. The results are shown on plates LIII and LIV. The plates are largely self-explanatory. Only a few specimens of each were used, but the shapes and sizes seemed to be fairly constant for the specimens from any given locality.

It will be noted that there are some differences, but often they are so slight that they would not be considered of much specific value. The pair of claspers of a species of *Buenoa* from Chile, South America, will be seen to be one about which there could be no mistake in saying that they are distinctly specific. Another one from the Superstition mountains, Arizona, is readily distinguished by its size. There are at least three types of spines which are quite distinct. While it may be said that these characters as a group are not of specific value, yet it must be acknowledged that there are several individual instances in which they are, no doubt, of specific value. Such a study as this needs to be worked out with a larger number of cases before absolute conclusions may be drawn.

Sound Devices. The following notes have been made of the number of setaceous teeth and spines on the sound-producing areas of the anterior legs of the males:

B. margaritacea: Right tibia, 27 teeth; left tibia, 26 teeth; one spine on the coxa.

B. elegans: Forty teeth on each tibia; 2 spines on the coxa.

Buenoa from Chile: Right tibia, 8 teeth (probably some broken off in handling; left tibia, 12 teeth. A row of spines on femur just opposite the teeth on the tibia. No visible sound-device area on the femur, and no spine visible at corresponding place on the coxa, as in the above species.

Other differences have been noted which have specific value. In specimens taken about Lawrence, Kan., and which superficially look much like *B. margaritacea,* the males have two constantly differing forms of the sound-producing areas on the front femora. Specimens from other localities have similar differences. Evidently there are several species not yet fully described.

INTERNAL MORPHOLOGY.

Brief and preliminary studies were made of the internal morphology in connection with working out the tracheal system and the associated hæmoglobin cells. Some notes and plates are given herewith showing the parts and structures which are not greatly different from what is found in other Hemiptera.

DIGESTIVE TRACT.

For a general idea of the digestive tract see plate XLVIII, figure 1. When dissected out it measures about two and one-half times the length of the body. Beginning at the head we find the salivary glands divided into four groups or clusters. The foremost group lies partly in the head next the beak and in the prothorax. The hindmost group lies farther back and mostly in the metathorax. Riley and Johannsen have figured the salivary glands of *Notonecta maculata* after Bugnion and Popoff in their "Handbook of Medical Entomology," page 28. For *Buenoa* practically the same sort of structure has been found.

The œsophagus is a long, slender tube as it extends through the thorax and beneath the dorsal apodeme as figured in plate XLIV. What appears to be the proventriculus is reached in the caudal part of the metathorax and extends for some distance into the abdomen. Sectioning shows no chitinous teeth or anything of the kind in this region, but the walls are very thick and seem to be of a glandular nature. The lumen at this point is little larger than in the œsephagus. No gastric cæca seem to be present, and if such ever have a glandular function, that function must be performed in *Buenoa* by the thickened glandular walls of the proventriculus.

The mid-intestine is considerably coiled about, but not as long as might be expected in an herbivorous animal. Toward the caudal end it appears to be somewhat segmented, and is supplied with a great many trachea.

Evidently the processes of digestion and absorption are quite active at that point.

The hind-intestine is rather small, as might be expected of a predaceous bug living on animal foods, but possesses a fairly large rectal cæcum, as do some herbivorous insects. At its anterior end arise the Malpighian tubules. These are brownish, knotty-appearing tubes, and when traced out thoroughly are seen to form two loops as shown in plate XLVIII. The two ends of each loop appear to arise from the intestine laterally at about the same point. If rectal glands are present they were not observed.

NERVOUS SYSTEM.

The ventral nervous system appears to possess five abdominal ganglia from which the nerves can be seen branching to the various organs. Its location in the abdomen is ventral, and on the mesal line below the hæmoglobin cell clusters, as shown in plates XLIV and XLV. In the thorax it is much larger and thicker, due to the three or four large ganglia there. Some cephalization of the ganglia of the entire ventral cord is observed. In the head the ocular lobes are quite large.

CIRCULATORY SYSTEM

The dorsal vessel, or heart, is found to be in the position indicated in plates XLIV and XLV. The enlarged portion next the dorsal line of the second to fifth segments of the abdomen has been mentioned on page 294. The aorta is seen to be much depressed in position by the dorsal apodemes of the thorax and to extend forward just dorsad of the œsophagus to the supraœsophageal ganglion, as is usually the case. Several times in dissecting, the heart was observed pulsating in the salt solution in which the specimen was immersed. Also, in the observations described on page 294 it was seen pulsing. The rate of pulse was about 70 per minute. The pericardial cells about the wing muscles seemed to have no definite arrangement in the specimens examined.

Locy, 1884, observed pulsating organs in the proximal ends of the tibia of a number of water bugs, including *Notonecta,* and described and figured those in *Benacus, Nepa,* and one or two others. He concluded that the organs which he observed were entirely separate from the musculature of the legs, and observed under magnification the corpuscles of the insect's blood flowing through them. He stated that the pulsating organs which he observed aided the flow of the blood in both directions through the extremities. The same phenomena were observed in this laboratory in the prothoracic and mesothoracic legs of *Buenoa*. This might be expected, since it is a genus related to *Notonecta*.

GENITAL SYSTEM.

The internal organs of the genital systems of both male and female are figured in plate XLVIII. In the male the testes appear to consist of three parts, and are located ventrally just caudad in the abdomen of the second abdominal spiracle. (See, also, Pls. XLIV and XLV.) Large tracheæ from that spiracle supply them and seem to support them. If a ligament of the testis or ovary was present in the specimens dissected it must have been very inconspicuous. Each part of the testis appears to consist of a long tube coiled up in a roll and inclosed in membranous covering. The vas deferens is a long tube of uniform diameter about two and one-half inches in length. The bug's body is only about 7 mm. long. This tube is coiled with its mate from the opposite side into a great mass in the caudal part of the abdomen. (See Pl. XLVIII.) Just before the two vasa deferentia extend caudad of this mass they unite into the ejaculatory duct. Near this union are three short-knobbed, glandlike organs, probably accessory glands.

In the female the ovaries are located and supported by the tracheal tubes from the second abdominal spiracle, as was found for the testes in the male. The oviducts leading caudad from them, dorsad and between the hæmoglobin cell groups, unite directly into the bursa copulatrix. From the dorsal surface of this, and at an enlarged portion, extends a long, coiled tube inclosed in a delicate membrane and with a knoblike enlargment at the end. This tube is about four times the length of the body of the adult insect, and appears to be the spermatheca. (See Pl. XLVIII, Fig. 2, *Sp.*)

RESPIRATORY SYSTEM.

The respiratory system is not greatly different in most respects from what is found in most Hemiptera. It consists in the main of ten pairs of spiracles in the nymphs, one of which is atrophied in the adults; longitudinal tracheæ on each side, from the caudal atrophied spiracle of the eighth abdominal segment to the mesothoracic spiracle of the suture between the mesothorax and the prothorax; and of transverse tracheæ between the corresponding spiracles of each segment, except possibly the metathorax, and the first and second abdominal segments. The longitudinal connection between the first and second abdominal spiracles is quite difficult to trace. The branching and rebranching and the extraordinary development of the tracheæ in the thorax is remarkable.

L'ORGANE TRACHEO-PARENCHYMATEUX. Ferriere, 1914, described and figured what he called, "L'Organe tracheo-parenchymateux de quelques Hemipteres aquatiques." These were two white organs on either side of the dorsal vessel in the thorax which were penetrated with a great number of small tracheæ. He found them in *Nepa, Ranatra,* and *Naucoris;* but did not find them either in *Corixa* or *Notonecta.* He seems to have concluded that they were degenerate groups of muscles in the thorax of insects which no longer used their wings as they once did in their phylogenetic development.

In plate XLIV is figured a remarkable group of tracheæ which in the thorax seems to be homologous with "L'Organe tracheo-parenchymateux" of Ferriere. There are other such groups of tracheæ in the thorax of *Buenoa,* but none so large and with such remarkable development of tracheæ as this one. The plate shows just one of them in lateral view. There are two just like the one figured. Each one lies in an almost vertical plane extending dorsoventrally on either side of a mesal rectangular group of muscles which extend caudo-cephalad between the anterior margins of the mesothorax and the large dorsal apodeme at the anterior margin of the metathorax. By carefully dissecting a dried fresh specimen of *Buenoa* they are most easily seen. Each one of these groups of tracheæ seems to supply the muscles between them. This must have been once true of the organs figured by Ferriere. The organs he described were white. These also are whitish when the tracheæ are filled with air. The organs he described in *Ranatra* were examined in specimens of *Ranatra fusca* and found to bear a marked resemblance to those of *Buenoa.*

HÆMOGLOBIN CELLS.

REFERENCES. The hæmoglobin cells, as mentioned in the introduction, are closely associated with the tracheal system and should be considered in connection with it. Definite hæmoglobin cells, or cells containing hæmoglobin, were first found in the larvæ of *Gastrophilus equi.* It appears they have been found in no other insect except *Buenoa.** They were first observed and described from the larvæ of the horse botfly by Enderlein (25), 1899. The next year, 1900, they were more fully described and figured by A.

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* Poisson Pages 192-201, Archives de Zoologie Experimentale, T. 65, Fas. 4, 1926, describes these cells in the genus *Anisops*

Prenant (64), of Nancy, France. Other short articles were written about these cells just previous to that time and immediately after. In 1909 Portier, in "Physologie de L'appareil respiratoire des larves D'Oestre," gave about the last original investigation concerning these cells that is found in the literature. Berlese, 1909, in "Gli Insetti" refers to the literature and sums up the knowledge then acquired. Rollet as early as 1861 had discovered that there was hæmoglobin in the common blood worm or Chironomus larva. But in the Chironomus larva there seem to be no cells in which the hæmoglobin is confined. Dr. H. B. Hungerford reported hæmoglobin in the cells of *Buenoa* in 1922.

ARRANGEMENT. The red cells in the abdomen of *Buenoa,* which in living material is a bright scarlet color and dark red or black in museum specimens, occupies in some cross sections of the body nearly one-third of the abdominal space. The groups into which these cells are clustered surround and are attached to the tracheæ which come from the spiracles of the third to the seventh abdominal segments, inclusive. (See Pls. XLIV and XLVI.) In plate XLVI will be seen something of the grouping of the cell clusters as they usually appear in specimens when the dorsum is removed.

There are two rows of the cell groups on each side of the meson. One row is on the outside from the meson. Through this row the main tracheal trunks arise dorsally from the spiracles beneath to the longitudinal tracheæ and digestive tract above. This outer row consists mostly of one cell group to each segment of the body. Sometimes the branch trachea leading to the digestive tract leaves the main stem trachea before it emerges above the cell group. This is true of those in the third and fourth segments especially. The others leave the stem above the cell cluster. (See Pl. XLVI.) Some of the cells are attached at the extremities of branch tracheæ coming from the main trunk arising through their midst. Others are attached at the extremities of tracheæ coming directly from the spiracle. (See XLVII, Fig. 2.)

The inner row of cell groups next the meson consists entirely of cells in groups about the ends of treelike branched tracheæ arising from the same spiracles as do the main trunk tracheæ. They are arranged in one group to each segment except in the fifth and sixth segments. There the spiracles are especially large, and the internal development of the tracheæ and the attached cells is correspondingly large. Often in the fifth and sixth segments in the inner row there may be four or five groups of the cells.

In segment three of the abdomen the cell groups are rather small, due to the fact that this part of the abdomen is largely occupied by the ovaries or testes which arise or are supported by tracheæ coming from the second abdominal spiracle. Also the length of this segment is much shortened, and near the meson the large apodeme with their attached muscles extend caudad from the first sternite.

Again the cell groups are somewhat smaller in the seventh abdominal segment. Here the reason is that the space is mostly taken over by either the large coil of vasa deferentia in the male or the coiled spermatheca in the female. Also, in the female especially, the more caudal segments are here retracted and occupy much of the space.

The tracheæ branching from the atrophied eighth abdominal spiracles do not supply hæmoglobin cells, but extend to the ovarian tubes or vasa deferentia and the parts of the genital segments.

Each cell group so named is loosely held together by a delicate peritoneal membrane. This delicate membrane may be demonstrated in two ways, either by gross dissection or by sectioning the abdomen. It is seldom in gross dissection that it will be seen, except when particular care is taken to shave off the group very carefully in physiological salt solution close to the spiracle. Usually it is broken and does not hold the cells together in a manner to attract attention. Many gross dissections were made before it was discovered.

The group with its surrounding membrane was transferred with a pipette and suspended in salt solution to a slide and studied under low-power microscope for some time before it would break. Frequently renewing the evaporating salt solution, by adding some that was fresh with a pipette, prolonged the time the membrane would hold intact. In such a position it appeared holding the cells in a cluster more or less spherical, as shown in plate XLVII, figure 3. After a time some of the cells would begin to hæmolyze, probably due to too much salt in the solution, which was constantly evaporating. The hæmolyzed material, like little reddish droplets of oil, would bubble out from the cluster through openings in the surrounding membrane. It was stated in the preceding paragraph that the cells seemed losely held together by the surrounding membrane. It may have been that there were natural openings in the membrane at frequent intervals, allowing the body fluid or blood to freely circulate between the hæmoglobin containing cells. Such is a matter which needs more demonstration. The membrane itself may have broken down in the supersaturated salt solution or it may have been slightly punctured in removing. This technique was repated several times, with always the same result.

On most every slide containing a number of sections of that part of the abdomen containing the hæmoglobin cells there are some which plainly show the inclosing membrane. Most of the slides in this study have been stained with eosin and Delafield's hæmatoxylin stains. But few nuclei have been observed in the membrane.

STRUCTURE. Plate XLVII, figure 1, shows the structure of the cell and the manner of its attachment to the trachea. The large tracheæ branch and rebranch into smaller tracheæ until the whole mass has much the appearance in form of a tree. At the end of the twigs or tracheoles (small tracheæ without tænidia, perhaps), the cells containing the hæmoglobin are attached. Each individual cell has about the shape shown in the figure, an oblong cell tapering at each end.

The masses of cells taken from fresh bugs were mounted in newly-made physiological salt solution on a slide and picked apart under a binocular with fine needles, so that the individual cells could be distinctly seen. A cover slip was then dropped over them, and they were carefully and repeatedly studied with the oil immersion objective and No. 10 oculars on a Bausch-Lomb compound binocular microscope. In this manner many details could be observed in the evidently yet-living cells. Most of the details were the same as were afterwards observed in sectioned material.

A number of tracheoles branch out from the point of attachment of the cell to the small trachea and pass out in almost parallel but curving lines toward the opposite pointed end of the cell. Cross sectioning shows most of these tracheoles to be just underneath the periphery of the cell. The periphery of the cell is a rather tough membranous covering retaining the protoplasm within. In the living, unstained material the nucleus is distinctly seen in the cytoplasm as a globular, lighter-colored area. Within it can be seen some darker areas but not in definite outline. The rest of the cell shows, aside from the nucleus and the tracheoles, an even, slightly pinkish color, due to the oxyhæmoglobin present.

In the fixed, mounted and stained material the same details of structure can be seen as given above. But the nucleus stains darkly with Delafield's hæmatoxylin, and the remainder of the cytoplasm an even pinkish color with eosin stain. In addition small granular-like specks are seen distributed throughout the cytoplasm and some larger, dark-stained bodies. Some may be fat bodies and some the by-products of the cell metabolism. (See plate XLVII.)

In most if not every detail of structure the cells are very much like those figured by Prenant in his "Notes Cytologiques" on the hæmoglobin cells of the larvæ of *Gastrophilus equi.*

DEVELOPMENT. Of the development of the hæmoglobin cells in *Gastrophilus equi,* Prenant, 1900, thought there were certain fat cells about the tracheæ which became modified into hæmoglobin cells. He gave a figure in one of the plates he produced, "planche XV, figure 3" of his "Notes Cytologiques VI," showing the gradations and all the stages between the fat cell proper and the cell containing hæmoglobin. But Prenant seems to have thought they were ectodermal in origin. Adipose tissue is usually considered mesodermal in origin. Berlese, 1909, in summing up the matter in "Gli Insetti," discusses the probability of whether they were ectodermal or mesodermal in origin.

Portier, 1909, in writing of the physiology of the respiratory apparatus of the horse botfly larva, said: "On a distingue deux sortes de cellules trachaeles; les unes anterieures, dont le protoplasma est bourre de reserves graisseuses; les autres posterieures, teintes d'hemoglobine." He did not discuss the origin and development of these cells, but simply made the above statement, and then discussed certain experiments which he tried on the living larvæ with various colored oils and other substances.

It has been noted that there are also two kinds of cells about the tracheæ in the abdomen of *Buenoa,* the fat cells and the hæmoglobin cells. This suggests that in this case, also, the hæmoglobin cells may be fat cells modified as in the horse botfly larvæ. The fat cells in the adult are found more especially around the tracheæ leading from the second abdominal spiracle. Also, some are found around the tracheæ leading from the other abdominal spiracles. Around these other spiracles they occur as a rather thin coating of fat just beneath the red cell clusters. Since the fat cells and the hæmoglobin cells are in close proximity, it may be that there is a transitional stage between them like that found by Prenant in the case of *Gastrophilus equi.* If such is true, it must occur in the early nymphal stages, for it has not been seen to happen in either the adults, the late instars, or in the developing embryo.

In the article announcing the discovery of the hæmoglobin cells it was stated that they "are found in the abdomen of the embryo not yet hatched." These studies have not verified that statement conclusively. Because eggs and first- and second-instar nymphs could not be secured till too late for a full investigation of the fresh material, this part of the work has not been completed satisfactorily.

Studies were made of the developing embryo within the egg. Eggs gathered May 14, and others laid in the laboratory May 15 and on the days succeeding this, were the ones most carefully studied. They were dissected from the plant by splitting the stem and pulling the halves away from the sides of the eggs. Then they were kept in small petrie dishes in pond water together with a little Ceratophyllum. This condition did not usually interfere with the development of the eggs if they were kept in water all the time and not subjected too long to heat and strong light. Eggs exposed to the strong light and heat of the binocular-stage light for more than two or three minutes never hatched. Embryos well developed within the egg chorion were observed when so placed to revolve round and round on their horizontal axis by movements with the tip of the abdomen. This must have been for the purpose of not leaving the one side exposed to the strong light and heat too long. They could not be seen to so revolve at other times. The studies were made with reflected and transmitted light under the binocular, and also under a Bausch-Lomb compound binocular microscope equipped with 16-mm. objective No. 10 oculars, and Abbe condenser. With a pipette the eggs were placed for examination in a drop of water on a slide.

For the first two days after the eggs were laid little differentiation could be seen from any position. Then certain of the large yolk bodies, scattered promiscuously about through the egg, became a light pink in color, and the germ band could be seen along the ventral side. The day following this, or the second day, the germ band was further developed and the appendages became very evident. The yolk bodies were of a slightly brighter red, and began to arrange themselves in rows dorso-ventrally along the sides of the egg. The development continued during the following days; but the red bodies, or yolk granules as they appeared to be, lost their coloring, except a few near the caudal end of the egg and a few near the center of the abdomen. The pink coloring matter became more and more diffused throughout the entire egg, except in those parts on the ventral side where the germ band and its appendages were most developed. Next the red coloring began to appear as two dorso-ventral red marks on the sides of the cephalic end of the egg. The red yolk bodies entirely disappeared, and the diffused pinkish color throughout the egg gradually disappeared as the eyespots took on more and more color, until about three days before hatching. At this stage no more pinkish color remained diffused through the egg. The yolk bodies on the dorsal side of the abdomen were nearly all gone, and two black streaks along the venter, representing the hairs to cover the ventral air channel, had developed. The eyes were bright red and well developed. But no indication of hæmoglobin cells could be seen in the abdomen. From this time until hatching little change was seen, except the disappearance of the yolk bodies in the abdomen. Most of the eggs hatched May 24 to 26.

In the first instar nymphs no indication of the hæmoglobin cells was seen. Many of them had a greenish tint in the fore part of the abdomen, but not the slightest trace of any red cells. The eyes were rather bright red when the nymph first hatched, but turned to darker shades of red as the nymph grew older. In the older nymphs and adults the eyes are brownish or black.

Egg fixed in Perenyi's fluid, chromonitric acid, and preserved in 85 per cent alcohol during the various stages of development, often show the eyespots and other red markings within the chorion still in their natural or nearly natural color. The color varies from a bright to a rather dark red.

Nymphal instars and adults, fixed in any of the various fixatives and preserved in 85 per cent alcohol, show the hæmoglobin cells to have turned from the bright-red color of the living material to a dark brown or black. Since the red coloring matter in the eggs does not change color when fixed and preserved, it must be an entirely different substance from that in the hæmoglobin cells. It seems very probable then, that the "red cells . . . found in the abdomen of the embryo not yet hatched," were not hæmoglobin cells, but the yolk or similar bodies containing the coloring substance which later accumulated in the eyes of the developing embryo. The study is being continued, and further observations may cause different conclusions.

Little more can be said at this stage of the investigation concerning the development of the hæmoglobin cells, except that preserved, sectioned, and living materials have shown them to be well developed in the third instar and those following.

PHYSIOLOGICAL FUNCTION. Examination of the literature concerning the hæmoglobin or tracheal cells of *Gastrophilus equi* has revealed very little about their physiological function. Doctor Hungerford wrote concerning those of *Buenoa:* "These large clumps of red cells are most intimately connected with the respiratory system, and might well serve to fix and store the oxygen as a reserve supply."

The fact that hæmoglobin is found present in the cells may seem *prima facie* evidence that their function is for the purpose given in the above quotation. To the writer's knowledge hæmoglobin serves no other purpose than to loosely unite with oxygen when brought in contact with it, and then release it again when surrounding conditions demand such. In the vertebrates it unites with oxygen in the lungs, is carried to other parts of the body, and there, as the conditions demand, is released. This cannot be true in *Buenoa*, for the hæmoglobin is confined to certain attached cells which do not circulate in a medium like the blood of the vertebrates.

There may be two or three possible ways in which the hæmoglobin of the cells in *Buenoa* function for the insect's body. In each case most of the oxygen must get to the hæmoglobin from the air through the tracheæ and their extensions which lead to and penetrate the cells. If this is not true, then it is a question why there should be such an elaborate system leading into them. Some oxygen may penetrate through the tissues, for it has been shown that gases, including oxygen, penetrate directly through chitin and other tissues. (Moore, 1916.) Some small insects have little or no tracheal system, although they are enveloped in a chitinous covering. At least we know there is a direct connection between the outside air and the interior of the hæmoglobin cells.

The first of the possible ways for the hæmoglobin in the cells to function is that the oxygen may reach them through the tracheæ and the tracheoles, be fixed there temporarily, and then be distributed to the tissues by the blood which bathes the hæmoglobin cells inside the membrane which surrounds them. It was indicated on page 306, in the discussion of the arrangement of the hæmoglobin cells, that the blood might so bathe them, but was not conclusively shown.

The second way may be similar to the first, except that the oxygen is diffused through the surrounding membrane to the blood and then distributed to the tissues. Since the membrane is very thin, the oxygen would very likely penetrate it more easily than it has been shown to do to chitin.

The first or second possible processes may be used wholly or in part. Muttkowski (53), 1921, by a series of experiments, demonstrated a respiratory protein in a great number of insects, but did not use *Buenoa*. He did use *Notonecta*, a related genus. The respiratory protein he called hemocyanin, and its nucleus he found to be copper. All the insects he used showed the presence of hemocyanin. It is probably also present in *Buenoa*. So a respiratory function for the blood of *Buenoa* must be included as being quite probable.

The third possible way is the same as the first and second, except that the oxygen may be released back to the air from which it first came, and from that through the tracheæ to the tissues. This is considered much more likely, but the first or second possible ways may be used slightly in coördination with it. This third way is supported by observations on the habits of the insect.

Muttkowski (52), 1920, points out that the air in the tracheæ of Odonata naiads is the same as in the water, approximately 65 parts nitrogen to 35 parts oxygen, as compared to 80 parts nitrogen and 20 parts oxygen in the atmosphere. When *Buenoa* has been beneath the surface of the water for some time the proportions of nitrogen and oxygen may be nearly the same as in the Odonata or other insects with a closed tracheal system. Now it will be recalled that in the discussion of the swimming habits of *Buenoa*, given on page 277 of this paper, that the insect uses effort at first after coming to the surface in order to keep itself below, and then later has to use effort to keep from sinking. The likely reason for this is that the oxygen of the fresh air secured at the surface unites with the hæmoglobin in the red cells and reduces the volume of the air buoying up the insect, so that it is soon well poised in the water. Then as the oxygen of the air in the tracheæ and ventral air chamber is used by the tissues, some of the oxygen from the hæmoglobin cells may be released back to the air in the ventral air chamber sufficient, perhaps, to keep the proportions of near 65 parts nitrogen and 35 parts oxygen as found in the surrounding water. Some of it may pass also to the respiratory protein of the blood, as was indicated by Muttkowski. After the oxygen supply has become depleted then the insect must return to the surface. The great length of time which the insect swims in almost perfect poise, compared to the lengths of time in which it is using effort either to get below the surface or to keep from sinking to the bottom, indicates very much that the above-described process is what occurs.

Krogh has devised an apparatus by which he was able to measure extremely minute quantities of gases. Tests can probably be made to give further evidence with respect to the air at different times in the ventral air chamber of *Buenoa*.

EXPERIMENTS.

A great number of observations were made and several experiments regarding the respiratory function of *Buenoa.* The following are typical of the swimming habits:

EXPERIMENT No. 1.

After a cool night, May 14, 1924, with the temperature in the laboratory at the time of the observations around 58 degrees Fahrenheit, notes were made on three adults of the species *B. margaritacea.* Each was in a separate jar of water sitting on a well-lighted window sill. The observations started at 9:30 a. m.

Bug No. 1:

At 9:35 a. m. it came with effort to the surface for air. Before obtaining the air it was heavier than the water, for it sank when it ceased momentarily to swim. After it obtained air at the surface it had to use considerable effort for nearly two minutes in order to regain its customary poise in the water. It maintained its poise with little effort until about 9:52, and then began to use more and more effort to keep from sinking to the bottom.

At 9:54:10 a. m. it touched the surface for renewed air supply, and then repeated the behavior as before.

Bug No. 2:

At 9:38:05 a. m. it touched the surface for air and then acted as did bug No. 1.

At 9:57 a. m. it again touched surface for air.

Bug No. 3:

At 9:44:35 a. m. it touched surface for air and repeated behavior of bugs Nos. 1 and 2.

At 10:04:45 a. m. it touched surface for air again, etc.

At 10:12 a. m. the observations ceased. None of the bugs remained at the surface for air more than four seconds. The periods between the times when they touched the surface film for air were as follows: Bug No. 1, 19 minutes 10 seconds; bug No. 2, 18 minutes 55 seconds; bug No. 3, 20 minutes 10 seconds.

The periods during which they were striving to keep below the surface after taking air could not be measured exactly, but were about 3 minutes for each bug.

The periods during which they were noticeably striving to keep from sinking to the bottom were about 1 minute each.

The periods during which they were swimming well poised in the water, due to the functioning of the hæmoglobin cells, were approximately as follows: Bug No. 1, 15 minutes; bug No. 2, 13 minutes; bug No. 3, 15 minutes.

No other creature in the insect world, so far as is known, can swim so nicely poised for anything like such a length of time. Surely this ability of *B. margaritacea* and the other *Buenoa* has a meaning all its own. The periods of time as given in the preceding experiment vary somewhat with temperature and other conditions. The shortest time observed for *Buenoa* to remain below without coming to the surface for air was 1 minute 10 seconds; and the longest time was 31 minutes 43 seconds with bugs collected from under ice and brought to the laboratory.

EXPERIMENT No. 2.

SUBJECT: *Buenoa margaritacea* Bueno.

OBJECT: Behavior when kept from the surface air.

PROCESS: Bugs were collected and put in aquarium jars at ordinary room temperatures. A wire screen made to fit closely to the bottom of the aquarium jar was dropped over the bug in the jar with as little disturbance to the bug as possible. The bug could not then return to the surface for air. The bugs were kept in laboratory two weeks or more previous to the experiment. Tap water was used and the bugs placed in the experimental jar at 7:30 of the preceding evening. The experiment began at 8:17 a. m., November 20, 1923. Different bugs were used for each trial.

Results: In the first trial it was found that the period of time, beginning when the bug last obtained air at the surface until it ceased activity, was 4 minutes and 10 seconds. Data given as follows:

Time.	*Intervals and notes.*
8:17:10 p. m.	Left surface film was covered with wire screen immediately.
	Interval: 50 seconds.
8:18 p. m.	Tried frantically to get to air.
	Interval: 3 minutes 20 seconds.
8:21:20 p. m.	No further activity except a faint kick now and then.
	Interval 40 seconds.
8:22 p. m.	Screen lifted and insect brought to surface and left floating
	Interval· 3 minutes.
8:25 p. m.	Recovered activity again.

Results: In the second trial, time till activity ceased was 8 minutes 45 seconds.

Time.	*Intervals and notes.*
8:42 p. m.	Bug at surface film, went below, covered.
	Interval: 2 minutes 10 seconds.
8.44:10 p. m	Tried for air.
	Interval 3 minutes 30 seconds.
8:45:30 p. m.	Frantic
	Interval· 3 minutes 30 seconds
8:48 p. m.	Less active.
	Interval 2 minutes 45 seconds.
8.50:45 p. m	All activity ceased
	Interval 1 minute 45 seconds.
8:52:30 p. m.	Screen removed, bug floated to surface on its side.
	Interval. 45 seconds.
8.53.15 p. m.	Spasms
	Interval. 1 minute 45 seconds.
8:55 p. m.	Active again.

Results: In the third trial, November 21, 1923, bugs kept in trial jar overnight, undisturbed. Time till activity ceased was 16 minutes 10 seconds.

Time.	*Intervals and notes.*
9:27:35 a. m.	At the surface for air.
	Interval: 9 minutes 10 seconds.
9.36 45 a. m.	Uneasy.
	Interval: 7 minutes.
9:43:45 a. m.	Sank to bottom and became quiescent; kicked some.
	Interval: 10 minutes 45 seconds.
9:54:30 a. m.	Brought to surface.
	Interval: 3 minutes 45 seconds.
9:57:15 a. m.	Active again.

Results: In the fourth trial, time till activity ceased was eighteen minutes, 20 seconds.

Time.	*Intervals and notes.*
10:04:10 a. m.	At surface; put screen over it.
	Interval: 5 minutes 20 seconds.
10:09:30 a. m.	Uneasy.
	Interval: 13 minutes.
10.22·30 a. m.	Sank, and time was not free to finish this trial.

It will be seen that the average interval until activity ceased was 12 minutes 16¼ seconds. The longest interval until activity ceased was eighteen minutes and twenty seconds; and the shortest was 4 minutes 10 seconds. The above experiment may be of some value or significance.

November 11, 1923, a large corixid, *Arctocorixa*, species unknown, was treated in the same manner as the above *Buenoa* were handled. The results are given below and are interesting for comparison: Time till activity ceased 38 minutes 10 seconds.

Time.	*Intervals and notes.*
9.33.45 a. m.	At surface for air; submerged; screen lowered over it without disturbance.
9:37:40 a. m.	Fastened to screen and quiet; wiped wings.
9.48 a m	Tried to come up; went down and kept quiet.
9:49 a. m.	Came to top of screen, and attached to a rock.
10 01 55 a. m.	Floated to top and all activity ceased.
10 05 10 a m.	Brought to surface, where it floated.
10:05 30 a m	Revived and began to swim about.

It will be seen that the time until activities ceased with the corixid given above was much longer than with the Buenoa. This fact seems to be in accordance with the observations of others on corixids and notonectids.

EXPERIMENT No. 3.

A number of observations were made to determine the comparison of the intervals at which various insects of the water come to the surface for air normally. In these experiments the insects were disturbed as little as possible. The first of these was *B. margaritacea* Bueno.

B. margaritacea Bueno: On November 21, 1923, out of 28 observations it was found that the insect came to the surface for air an average of once in 2 minutes 51¼ seconds. The shortest interval was 50 seconds, and the longest interval was 4 minutes 35 seconds. All the observations in this case were made with the same bug as it swam in an aquarium jar at ordinary room temperature.

On November 22, 1923, the same observations were made with another bug. Out of five observations it was found that the average interval was 1 minute 54 seconds. The shortest was 1 minute 40 seconds, and the longest 2 minutes 40 seconds.

On November 27, 1923, the experiment was again repeated with another bug which had been in the aquarium jar for several days. Out of eleven intervals observed, the average was found to be 6 minutes 28 seconds. The shortest was 3 minutes 40 seconds, and the longest 8 minutes 57 seconds.

Of all the observations on *B. margaritacea* Bueno, some 44 altogether, the average was three minutes 48 seconds. The shortest interval was 2 minutes 17 seconds, and the longest was 5 minutes 11 seconds. These results are about what may be expected on the average in the laboratory. Conditions being different in the ponds, variations would occur there.

Notonecta undulata: The average interval during which this insect stayed under water in the laboratory as observed was 7 minutes 25 seconds. The shortest was 5 minutes 45 seconds, and the longest was 10 minutes 5 seconds.

Arctocorixa sp.: In a few short observations it was found the average interval of immersion without coming to the surface for air was 40 seconds; the longest 49 seconds, and the shortest 8 seconds.

Small dytiscid, species unknown: A few observations were made with this insect as with the preceding, and it was found the average was 3 minutes 56 seconds; the shortest 50 seconds, and the longest 5 minutes 5 seconds.

Cybister fimbriolatus Say: Average 6 minutes 35 seconds; shortest 20 seconds, and longest 11 minutes.

An average table of the intervals at which the preceding insects came to the surface for air may be of interest, and is given here:

Species.	*Average interval: min sec.*	*Shortest: min. sec.*	*Longest: min. sec.*
B. margaritacea Bueno	3:48	2:17	5:11
Notonecta undulata Say	7·25	5.45	10: 5
Arctocorixa sp.	0:40	0: 8	0:49
Unknown dytiscid, small species.	3:56	0 50	5: 5
Cybister fimbriolatus Say	6:35	0·20	11: 0

Ranatra fusca was kept in the laboratory during an entire winter, and frequently observed as to the frequency with which it came to the surface for air, but its habits are unusual in this respect. It hangs for hours sometimes at the surface and at other times lies motionless for just as long at the bottom. No exact time records were made of it.

The above experiments were repeated on a small scale with *Buenoa margaritacea*, a small *Corixa* species, *Arctocorixa* species, *Cybister fimbriolatus*, and a small unknown species of hydrophilid. All were observed under identical conditions of water, temperature, light, oxygen content, and surrounding conditions. The results were practically the same as in the experiments given on the preceding pages.

It will be seen that the above experiments have amounted to very little so far as proving anything about the hæmoglobin cells of *Buenoa* is concerned. It was thought at first there might be a comparison that would be much in favor of *Buenoa* being able to stay beneath the surface of the water for longer periods of time because of the hæmoglobin cells which it possesses. The table above shows that several other insects average longer periods beneath the surface than does *Buenoa*. There is this fact to be taken into consideration, however. *Buenoa* is in somewhat constant motion at all times. Seldom is it seen at rest on the bottom or elsewhere. All the other water insects, while not hanging at the surface film or objects beneath the surface, are engaged in considerable activity, thus using their oxygen supply quickly. When not active they may cling to objects below the surface and remain there for hours, or periods of time often longer than is the case with *Buenoa*. It is felt, therefore, that a comparison of the intervals of time spent beneath the surface of the water by various insects is of no value so far as proving anything definite about the function of the hæmoglobin cells.

GENERAL SUMMARY.

The results of these studies may be summarized as follows:

1. Some additional life history and biological notes have been added.
2. The external morphology of *Buenoa* has been more fully investigated.
3. Specific characters have been more closely examined and have shown the possibilities of certain heretofore undiscovered structures for specific determinations.
4. The internal morphology has been worked out in a general way.
5. The hæmoglobin cells in *Buenoa* have been further investigated as to structure, development, and function.
6. Certain details of technique in handling such a problem have been further developed.

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EXPLANATION OF PLATES.

PLATE XLIV.

Female. Sinistral view, body section.

External: A, antenna. C, coxa. E, eye. F, femur. I-XI, abdominal segments. 1-9, sternites. Lr, labrum. md, mandibles. Mst, mesothorax. Mt, metathorax. Ovip, ovipositor. Pt, prothorax. S_{1-7}, abdominal spiracles. Sms, mesothoracic spiracle. Smt, metathoracic spiracle, St, sternal gonapophyses. Sty, styli. tc, tarsal claws. Ti, tibia. Tr, trochanter. tr, tarsal segments.

Internal: Ao, aorta. Dv, dorsal vessel or heart. H, hæmoglobin cell groups. IC, internal apodeme, anterior margin of metathorax. Ic, internal apodeme, posterior margin of metathorax. l, longitudinal trachea. M, muscles. Mp, Malpighian tubules. N, ventral nerve cords. Oe, œsophagus. Ovd, oviduct. Ov, ovaries. Pv, proventriculus. Rc, rectal cæcum. Sp, spermatheca. TP, tracheoparenchemateux. tv, transverse trachea.

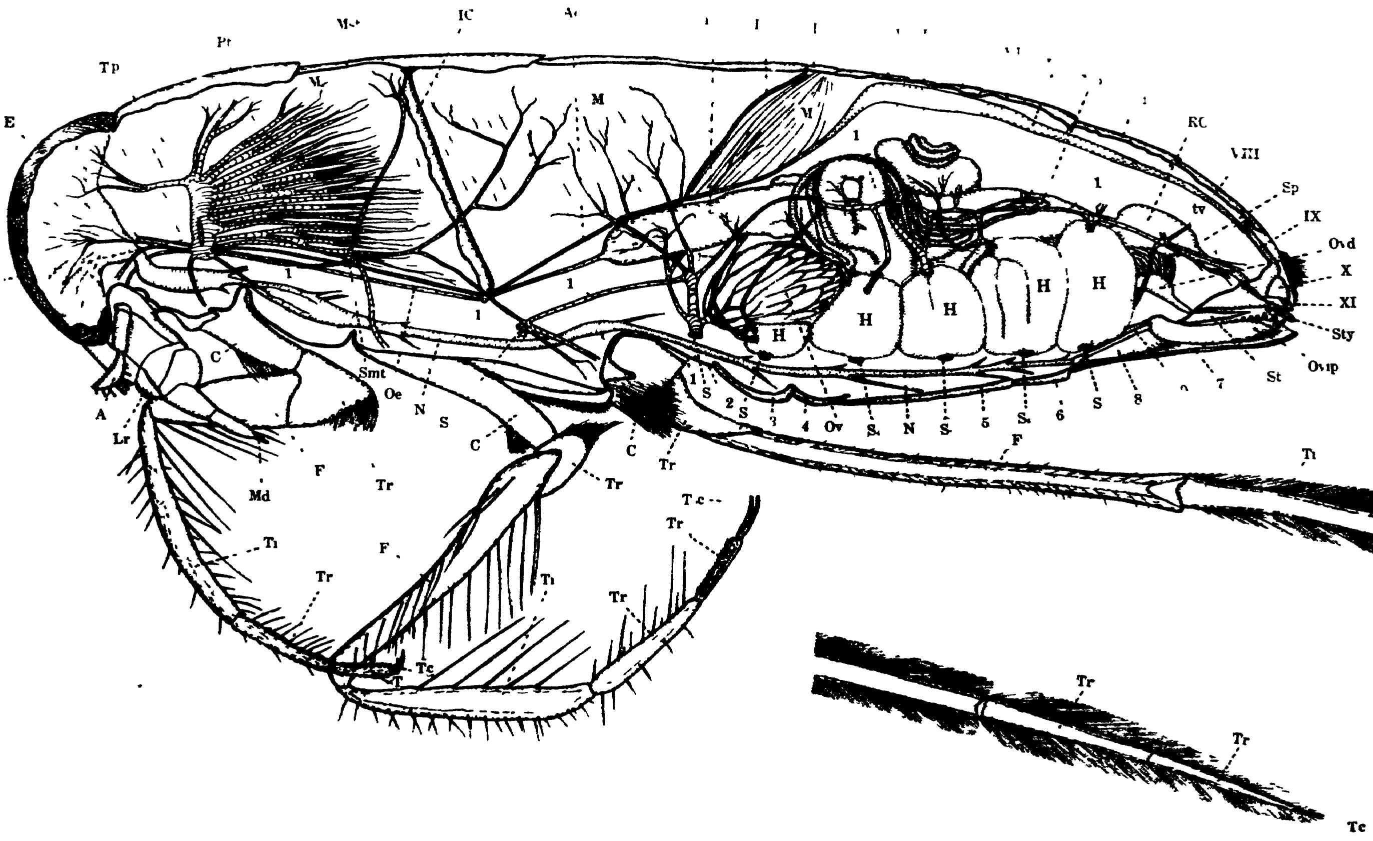
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PLATE XLV.

Male and female. Body sections.

FIG. 1. Head and foreleg of male: A, antenna. Lr, labrum. Sd, sound devices on beak, femur and tibia. Ti, tibia. Tr, trochanter, Tc, tarsal claws.

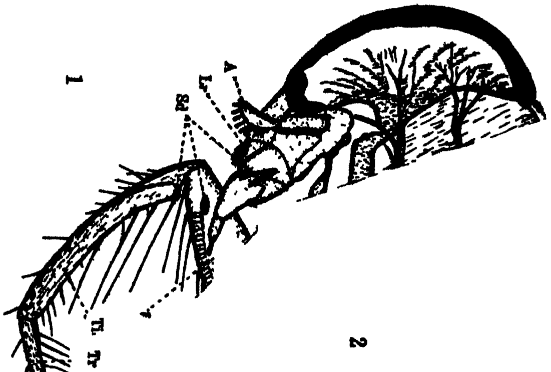
FIG. 2. Male: Ts, testis. S, spiracle. H, hæmoglobin cell groups.

FIG. 3. Female: H, hæmoglobin cell groups. 1-7, 8, 9, sternites. M, muscles. tv, transverse trachea. Lt, longitudinal trachea. I-XI, abdominal segments. Epi, epimeron. Eps, episternum, S_3-S_8, abdominal spiracles. T, tergum. St, sternal gonapophyses. Ovip, ovipositor. Sty, styli. Ic, internal chitinous process or apodeme, posterior margin of metathorax.

FIG. 4. Metathoracic leg: Tr, trochanter. Tc, tarsal claws.

FIG. 5. Male: Rc, rectal cæcum. Oed, œdagus. Gc, genital claspers. Vd, vas deferens. Ag, accessory glands (?). VIII-XI, abdominal tergites.

PLATE XLV.



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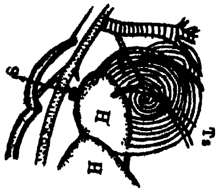

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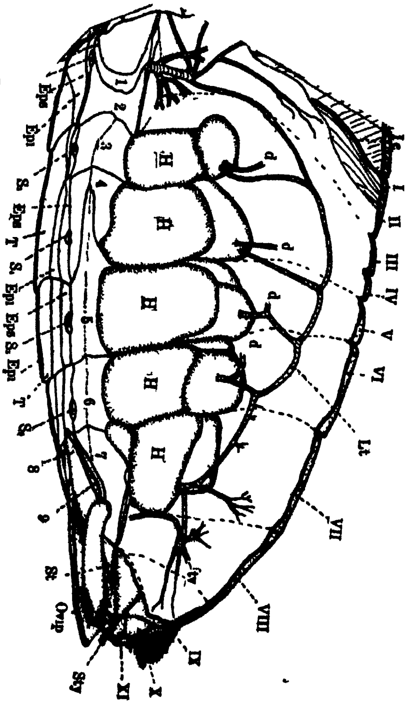

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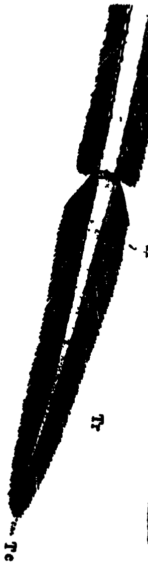

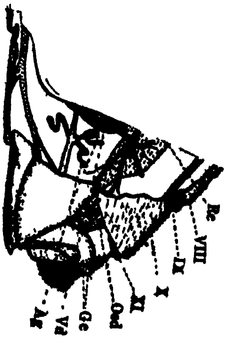

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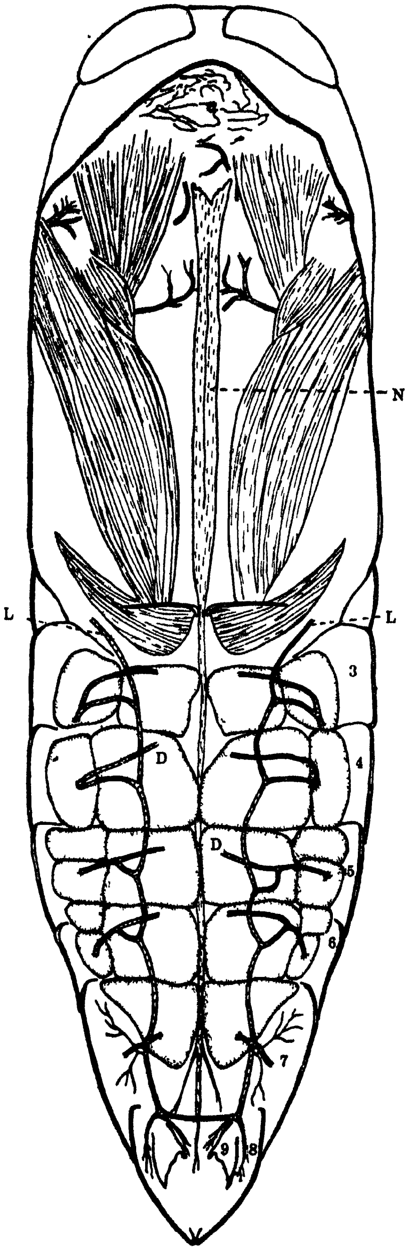
PLATE XLVI.

FIG. 1 Dorsal view of body section, showing arrangement and location of hæmoglobin cell groups in abdomen D, tracheal branches leading to alimentary tract L, longitudinal tracheæ N, ventral nerve system 3-9, abdominal segments

FIG 2 Dorsal view body section, showing ventral sclerites and spiracles from which arise the tracheæ and hæmoglobin cell clusters in the abdomen Epi, pleurite next tergum Eps, pleurite next sternum Ovip, ovipositor S, spiracles T, tergum III-VII, abdominal sternites 8, 9, terga of seventh and eighth abdominal segments

PLATE XLVI.



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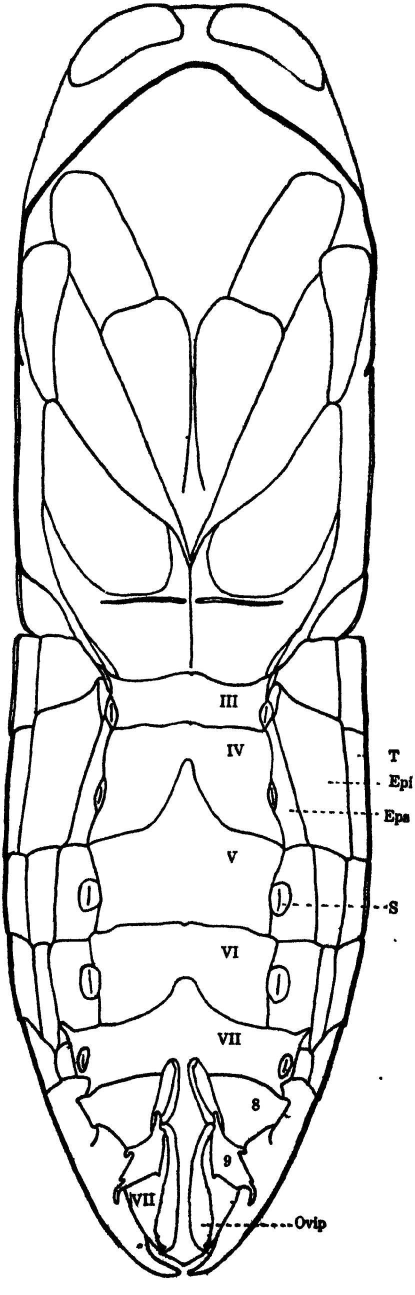

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PLATE XLVII.

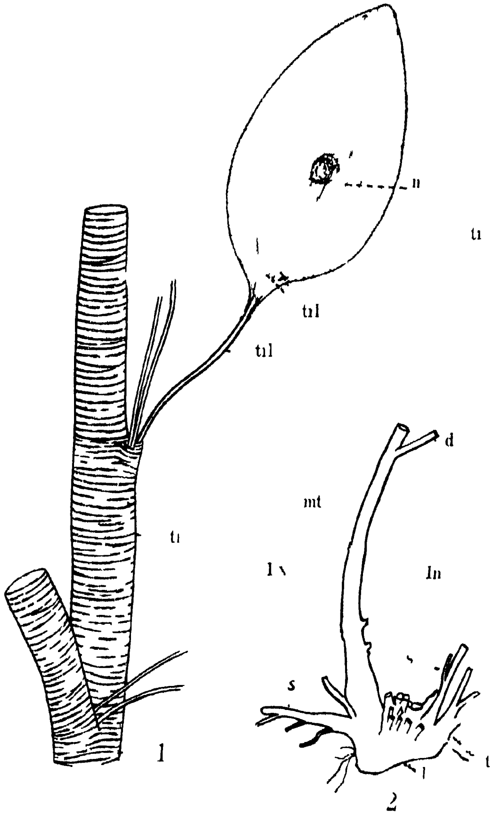
FIG. 1. (Oil immersion; in salt solution.) Piece of trachea showing hæmoglobin cell attached: n, nucleus, tr, trachea, with characteristics tænidia, tr, tracheoles. trl′ tracheoles, or small tracheæ with no tænidia.

FIG. 2. (Low power; in salt solution.) Tracheæ from fourth abdominal spiracle, caudal view, sinistral side of body · b, base of tracheæ opening over spiracle below. d, branch leading to digestive tract. Ex, direction of exterior of body. In, direction of interior of body. mt, main trunk of tracheæ, leading to longitudinal tracheæ above. s, stubs of tracheal branches leading into hæmoglobin cell clusters. tv, transverse trachea.

FIG. 3. (Low power; salt solution.) Two clusters of hæmoglobin cells shaved off sharply next the spiracle, showing how clusters are held together by a delicate membrane, as at a and b: a, membrane inclosing large cell cluster. b, membrane inclosing small cell cluster. s, opening of tracheæ to spiracle. tr, tracheæ.

FIG. 4. (Oil immersion; salt solution.) Base of tracheæ about spiracle. Spiracle with peritremes represented by dotted lines.

FIG. 5. (Low power; salt solution projection.) Hæmoglobin cell clusters to show tracheæ and manner of hæmolyzing: a, oillike red globular drops as hæmolysed from cell cluster. Tr, tracheæ.



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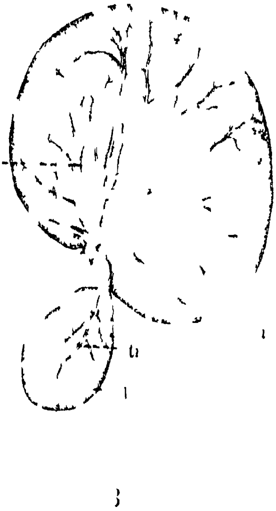

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PLATE XLVIII.

FIG. 1. Digestive tract: Mi, mid intestine. Mp, Malphighian tubules. Oe, œsophagus. Pv, proventriculus. R, rectum. Rc, rectal cæcum. Sal, salivary glands. tr, tracheæ.

FIG. 2. Female genital organs: Bs, bursa copulatrix. Ov, ovarics. Ovid, oviducts. Sp, spermatheca. tr, tracheæ.

FIG. 3. Male genital organs: Ag, accessory glands (?). Ej, ejaculatory duct. Ts, testes. Vd, vas deferens.

PLATE XLVIII.

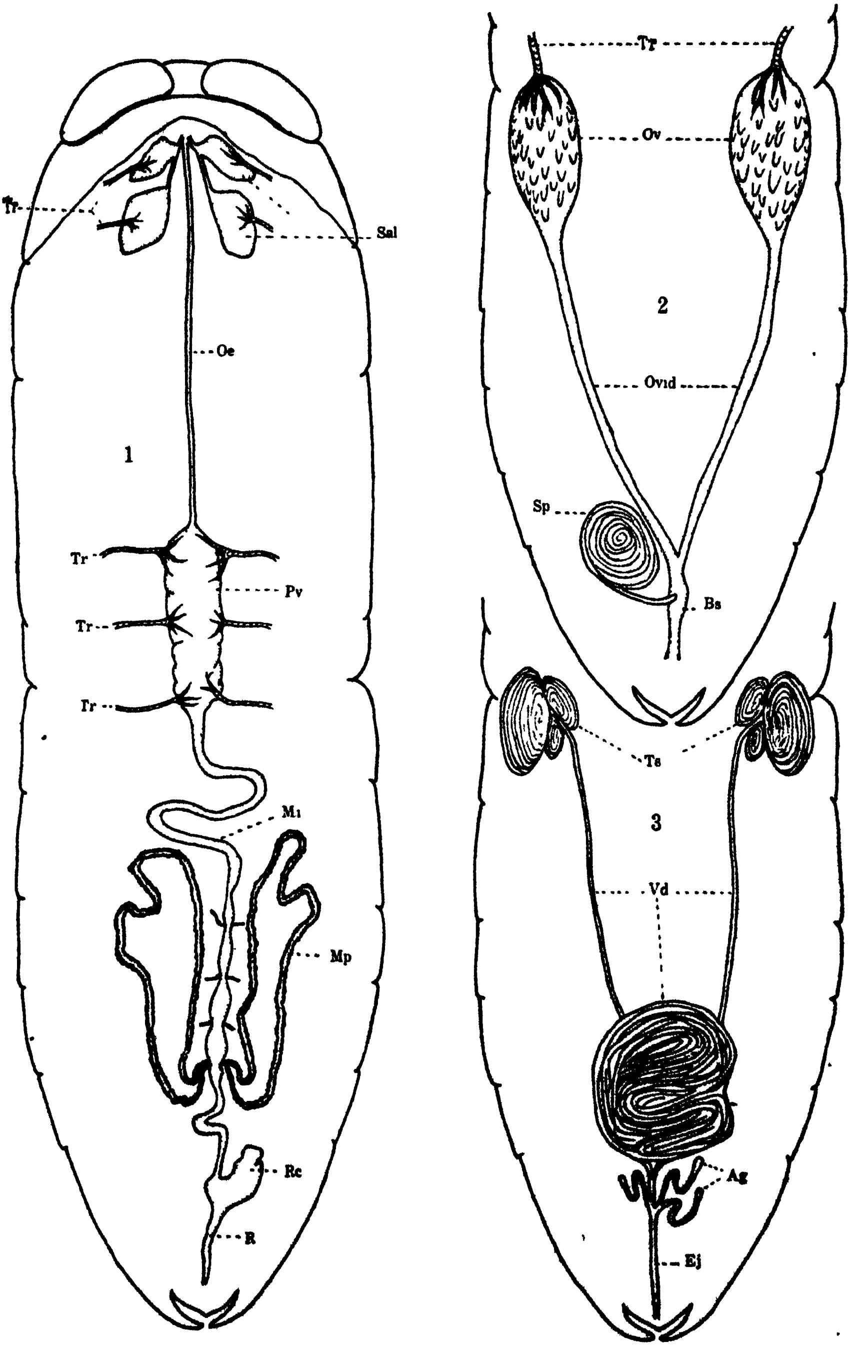


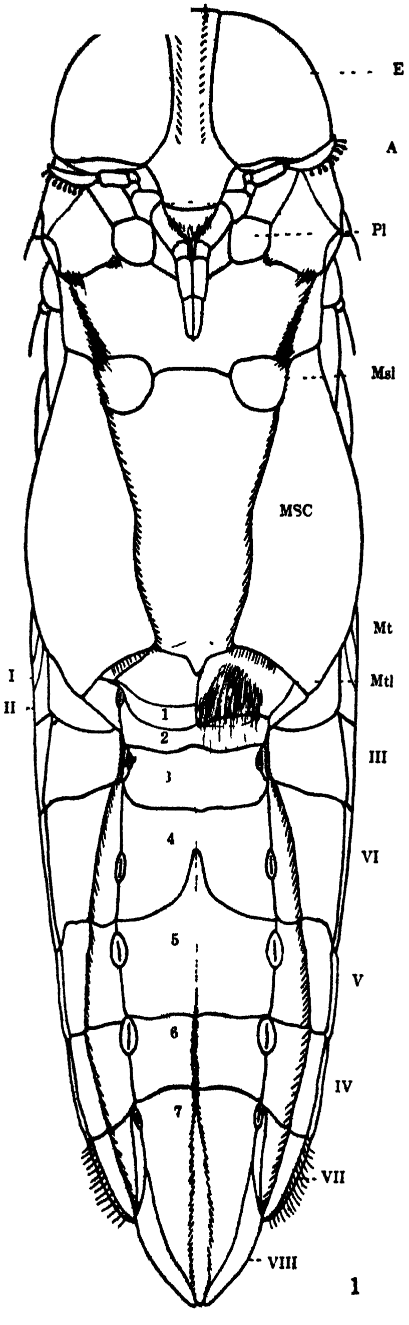
PLATE XLIX.

External anatomy.

FIG. 1. Ventral view female *B margaritacea:* A, antenna. E, eye. I-VIII, abdominal tergites. 1-7, abdominal sternites. MSC, extension of mesothoracic tergum (Rich). Msl, mesothoracic leg, foramen. Mt, metathorax. Mtl, metathoracic leg, coxa. Pl, prothoracic leg, foramen.

FIG. 2. Dorsal view female *B. margantacea:* Ao, thinly chitinous area dorsad of dorsal vessel, or heart. 1-X, abdominal tergites. Mst, mesothorax. Mt, metathorax. Pt, prothorax. Syn, synthlipsis.

PLATE XLIX.



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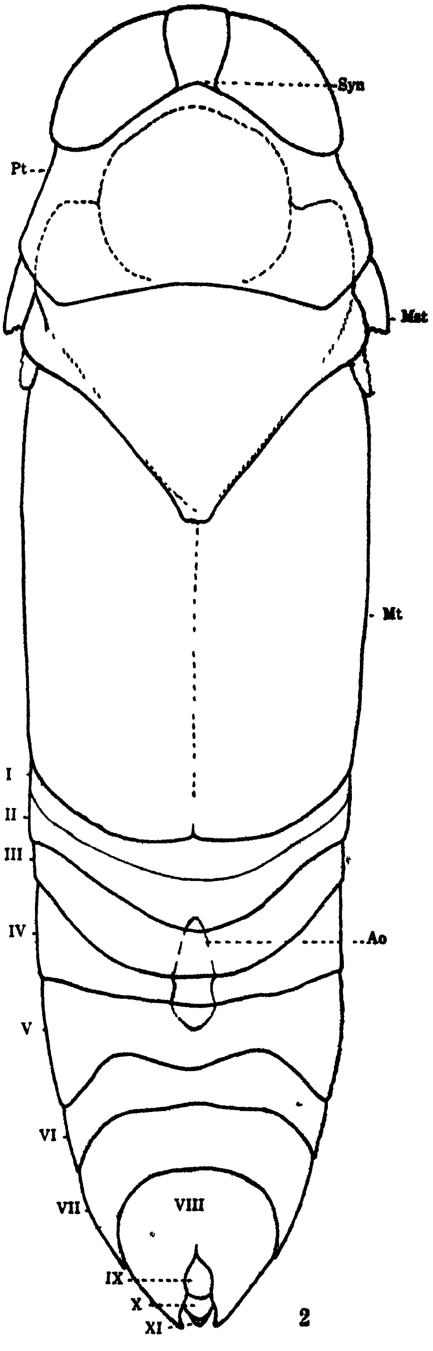

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PLATE L.

External morphology.

FIG. 1. Front wing: B, fastening or hook which hooks into groove on dorsal line at cephalic end of metathorax. L, fastening or hooklike device hooking into similar device at L in Fig. 3. Venation: Costa and subcosta of Comstock-Needham system probably fused along front wing margin. Media and radius fused and extending together into the corium. Cubitus forming back margin of corium. 1st A, 2d A and 3d A combined, found in clavus.

FIG. 2. Hind wing: C, costa. (Comstock-Needham system.) e, probably a remnant of subcosta. F, Subcosta two and radius one. R, Radial sector. M, Media and radius. D, Media and radial sector.

FIG. 3. Side view thorax of male: A, attachment of front wing. A' attachment of hind wing. Ac, antecoxal piece (?). C, coxæ. F, femur. G, glandular opening of the male. L, wing button. MSC, extension of mesothoracic scutellum (Rich). Mst, mesothorax. mst, mesothoracic scutellum. Mt, metathorax. mt, metanotum. Pt, prothorax. pt, pronotum. S, mesothoracic spiracle, beneath. S, first abdominal spiracle. smt, metathoracic spiracle. w, groove into which front wing fits. 1 and 5, mesothoracic pleurites. 2 and 3, metathoracic pleurites. 4, antecoxal piece. 6, mesothoracic sternum.

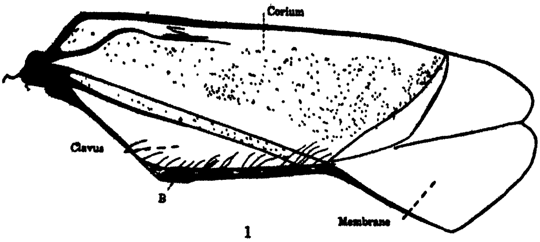
FIG. 4. Sideview thorax and abdomen: A', attachment of metathoracic wing. B, hook for fastening mesothoracic wing. C, coxæ. Epi and Eps, pleurites of abdominal segments. F, femur. I-XI, abdominal segments or tergites. MSC, extension of mesothoracic scutellum (Rich). Mst, mesothorax. mst, mesothoracic scutellum. Mt, metathorax. mt, metathoracic tergum. Ovip. ovipositor. S, spiracles. St, gonapophyses. Sty, styli or gonapophyses. Tr, trochanter. 1-7 of abdomen, sternites. Of thorax: 1 and 2, pleurites of metathorax. 3 and 4, pleurites of mesothorax. 5, mesothoracic sternum. 6, antecoxal piece of metathorax. w, groove into which margin of front wing fits.

FIG. 5. Caudal view of metathorax: A, apodeme. B, lateral margin of metanotum. D, median dorsal line of metanotum.

FIG. 6. Cephalic end of mesothorax, cephalic view: A, lumen of the mesothorax. B, prescutum. C, scutum. D, scutellum. E, pleurites. L, leg. S, sternum.

FIG. 7. Caudal view of prothorax: D, pronotum. F, fringe of setaceous hairs just caudad of mesothoracic spiracle. S, prothoracic sternum.

PLATE L.



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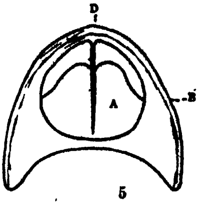

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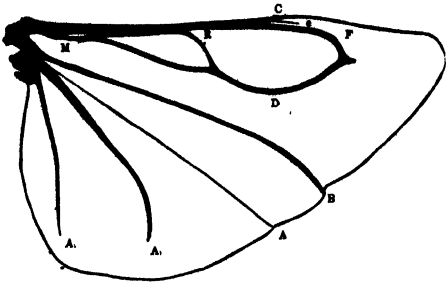

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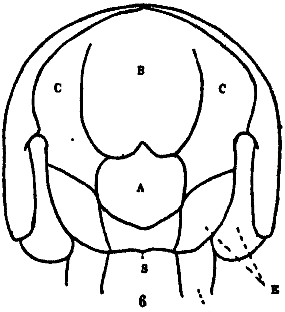

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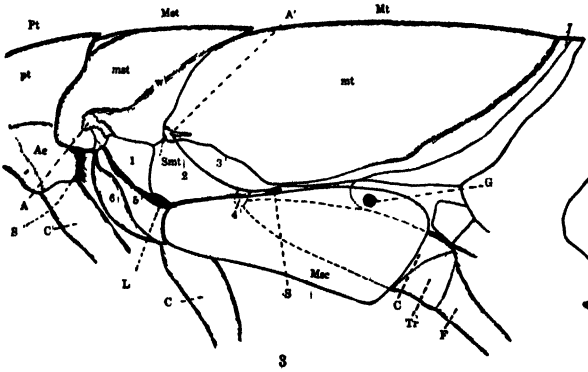

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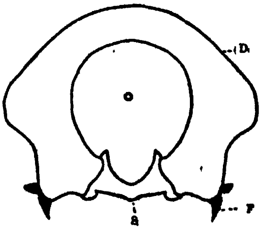

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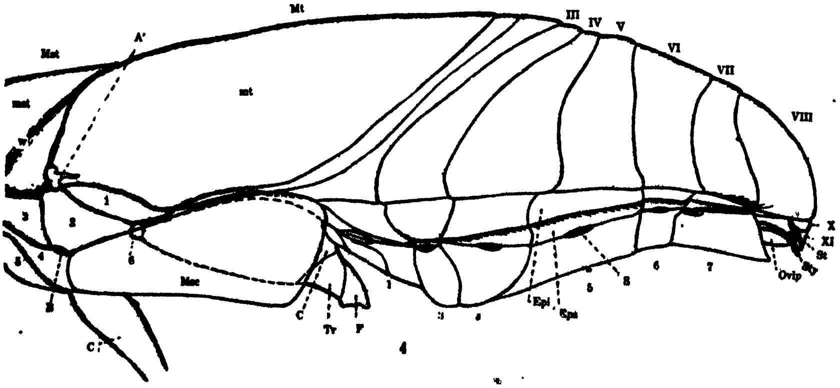

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PLATE LI.

FIG. 1. *B. Margaritacea* (oil immersion). Glandularlike apparatus as pulled out from male showing internal mass of tissues which cling to it: A, mass of tissue mentioned above. B, cells at external opening very darkly chitinized or pigmented. C, opening. L, lines in chitin about opening, apparently sutures.

FIG. 2. *B. margaritacea* (oil immersion). Glandularlike apparatus of male, vertical view from exterior of body.

FIG. 3. (Low power.) Antenna of *B. margaritacea:* A, proximal segment. b, called penultimate segment in literature. c, may represent third segment. d, distal or ultimate segment. e, spatulate, setaceous hairs.

FIG. 4. (8 ocular, 32 objective, Spencer.) Somewhat diagrammatical arrangement of sound apparati of male *B. margaritacea*: A, antenna. C, coxa. Cl, clypeus. E, eye. Ep, epicranium or frons. F, femur. lb, labium. lr, labrum. mx, mandibles and maxillæ. Ti, tibia. Tr, trochanter. Ts, tarsus. Tsc, tarsal claws. 1, thickened angular corner, sides of face. 1′, corresponding setaceous spines and thickened corner of femur. 2, areas on beak prongs. 2′, area on tibia, 3, spur on coxa. 3′, area on femur.

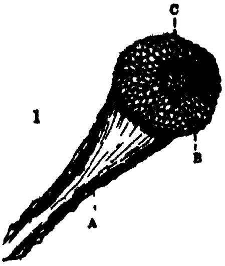
FIG. 5. (Oil immersion, balsam.) Apparatus on front tibia of *B. margaritacea:* A, cephalic end of area. A′, caudal end of area. B, point at which the apparatus is bent in mounting. AA′, whole stridular area. S, row of setaceous spines in view ventrally.

FIG. 6. (Oil immersion, balsam.) Apparatus on mesal face of front femur of male *B. margaritacea:* A—A′, stridular area, consisting of transverse thickenings of the chitin. H, strong setaceous spines which aid in forming crib of the front legs for retaining prey. G, glandular-appearing areas in the chitin or just below.

FIG. 7. (Oil immersion, balsam.) Apparatus on prong of beak of *B. margaritacea:* A—A′, sound producing area with row of spines or setaceous teeth down the middle of the area.

FIG. 8. (Oil immersion, balsam.) Large setaceous spine on outer face of the front coxa in *B. margaritacea,* for sound production, no doubt: M, proximal margin of coxa next the sternum. S, sound producing spine or spur. s, ordinary setæ on the surface of the coxa around the larger one.

PLATE LI.



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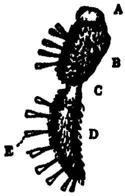

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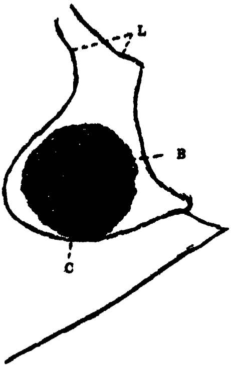

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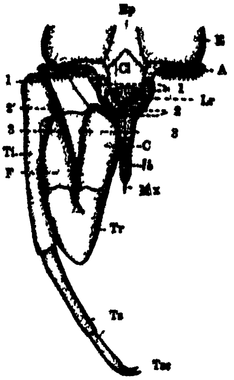

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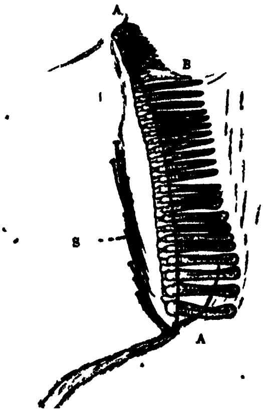

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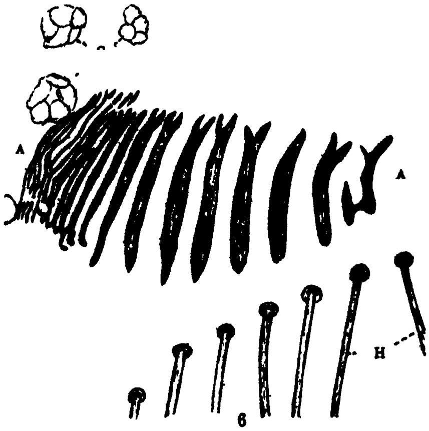

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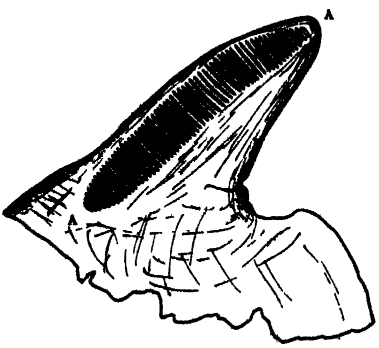

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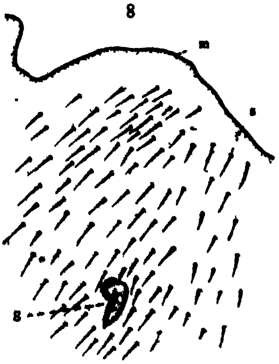


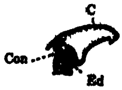
PLATE LII.

Adult male genitalia and abdominal sclerites.

FIG. 1. Left clasper, sinistral view.
FIG. 2. Dorsal view of claspers and connective.
FIG. 3. Right clasper, dextral view.
FIG. 4. Genital bulb, dextral view, claspers extended.
FIG. 5. Genital bulb, dorsal view, ninth abdominal sternite, etc.
FIG. 6. Genital bulb, ventral view, ninth abdominal sternite.
FIG. 7. Genital bulb, sinistral view, claspers retracted.
FIG. 8. Dextro-lateral view, tip of abdomen.
FIG. 9. Caudal view, tip of abdomen.
FIG. 10. Sinistro-lateral view, tip of abdomen.
FIG. 11. Dorsal view, tip of abdomen.
FIG. 12. Ventral view, tip of abdomen.

Lettering: C, clasper, or claspers. Con, connective. Ed, œdagus. Epi, pleurite next tergum. Eps, pleurite next sternum. Gb, genital bulb, ninth abdominal sternite, hypandrium. Lc, left clasper. Rc, right clasper. S, spiracle, Sp, spine on or near caudo-sinistral margin of seventh tergite, of abdomen. VI-XI, abdominal segments, or tergites. 8, eighth abdominal sternite.

PLATE LII.



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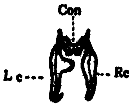

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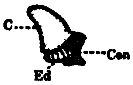

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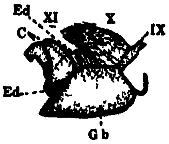

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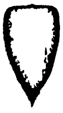

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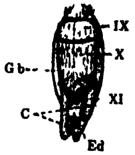

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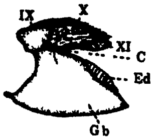

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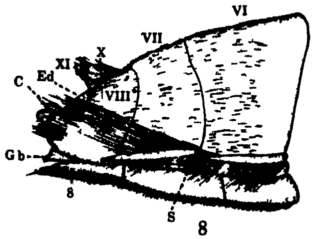

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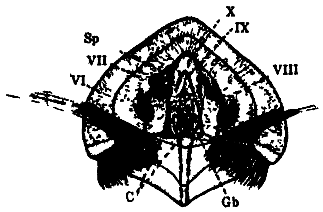

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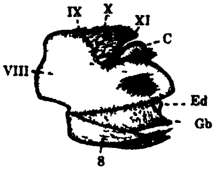

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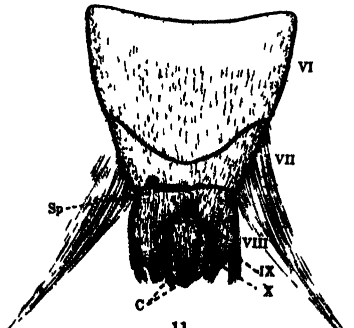

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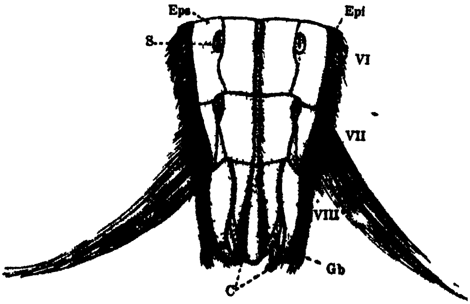

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PLATE LIII.

Genital claspers and spines, male.

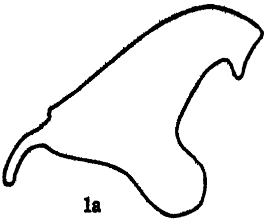
Left clasper at left of plate, spine of sinistro-caudal margin of seventh tergite at center, and right clasper at right of the plate.

FIG. 1. *Buenoa elegans* Fieb.

FIG. 2. *Buenoa margaritacea* Bueno. Collected at "Union Pacific bridge pond" Douglas county, Kansas, May 15, 1924. Clarence O. Bare.

FIG. 3. *Buenoa macrotibialis* Hungerford. From a paratype specimen loaned by Dr. H. B. Hungerford; collected in Bryant's bog, Douglas lake, Michigan, August 3, 1923.

PLATE LIII.



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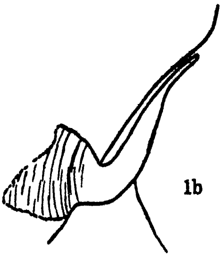

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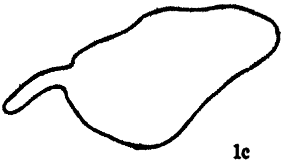

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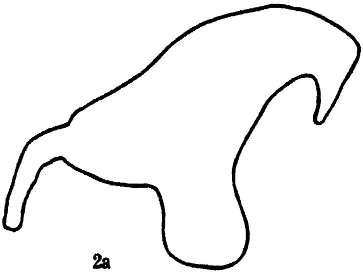

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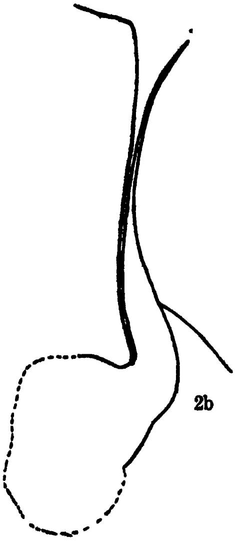

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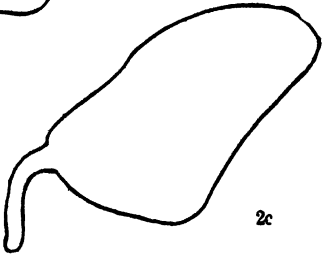

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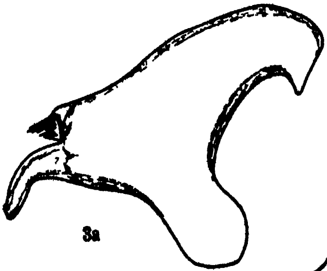

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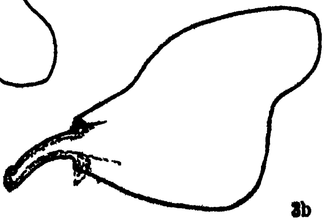

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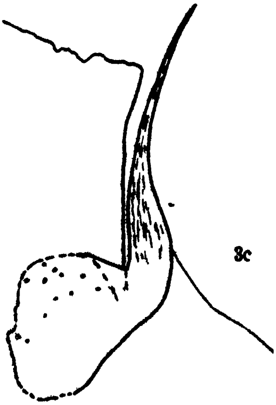

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PLATE LIV.

Buenoa males, claspers and spines.

Explanation: Left clasper on left side of plate. Spine from caudo-sinistral margin of seventh abdominal tergite, in middle of the plate. Right clasper on right side of plate, sinistral view. Parts from each individual specimen arranged horizontally across the plate.

Labels borne by the specimens as follows:

No. 1: H. B. Hungerford, Stubb's pond, Douglas county, Kansas, November 27, 1922. *Buenoa scimitra* Bare.

No. 2: H. B. Hungerford, Bryant's bog, Douglas lake, Michigan, July 29, 1923. *Buenoa elegans* Fieb. (?).

No. 3: H. B. Hungerford, Sedge Point pool, Douglas lake, Michigan, July 13, 1923. *Buenoa elegans* Fieb. (?).

No. 4: H. B. Hungerford, Benson, Minn., August 23, 1922. *Buenoa elegans* Fieb. (?).

No. 5: P. A. Glick, Superstition mountains, Arizona, November 7, 1922. *Buenoa arizonis* n. sp. (A full description of this will follow.)

No. 6: Alfredo Faz, Termas Cauquenes, Chile, South America, December 15, 1922. *Buenoa naias* Kirk.

PLATE LIV.

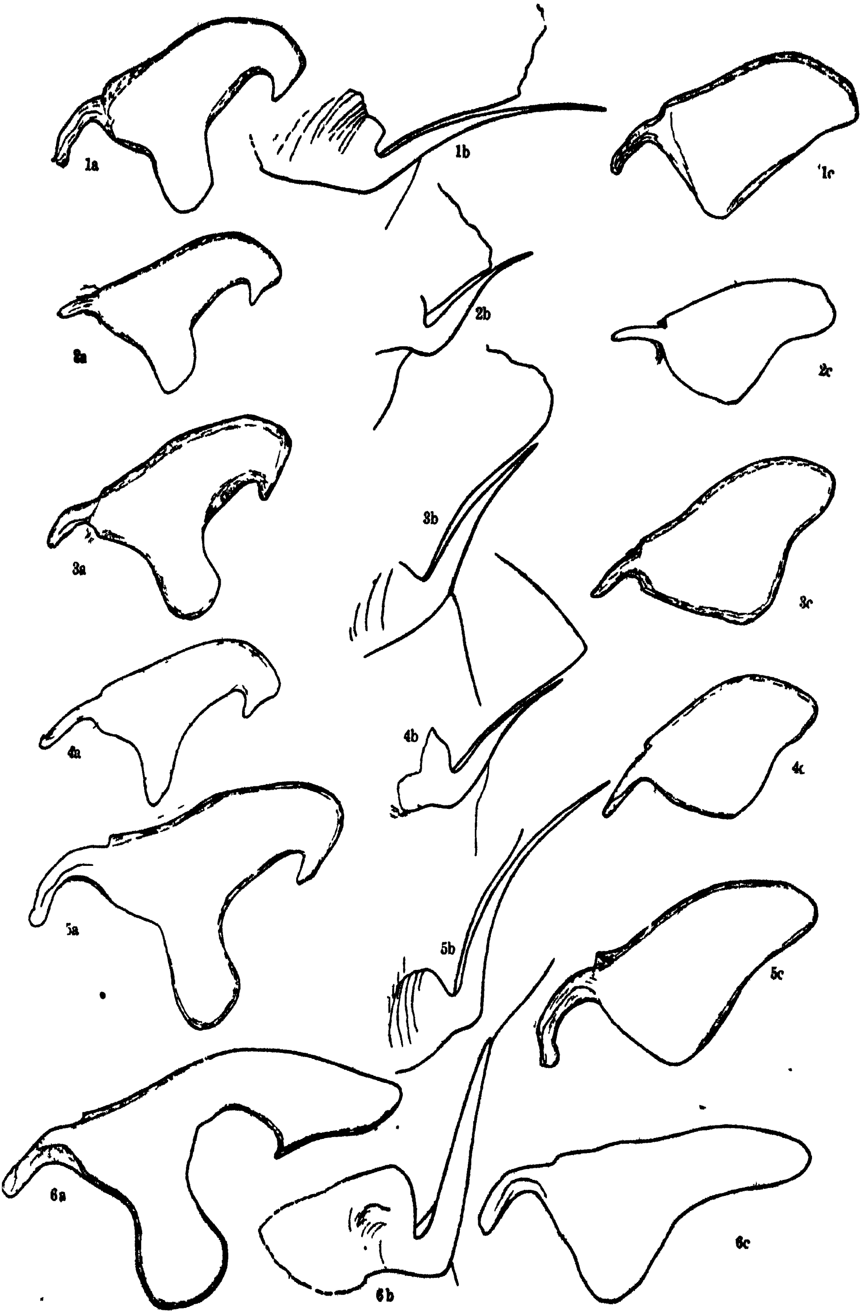


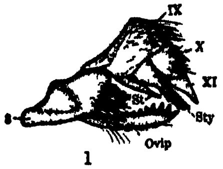
PLATE LV.

Adult female genitalia and abdominal sclerites.

FIG 1. Sinistral view of genitalia.
FIG. 2 Ventral view of genitalia as shown in Fig. 1
FIG. 3. Mesal view of ovipositor and adjacent parts.
FIG. 4. Dextral view of tip of abdomen.
FIG. 5. Caudal view of tip of abdomen.
FIG. 6. Sinistral view of tip showing genital parts.
FIG. 7. Caudal view of tip of abdomen
FIG 8. Ventral view of tip of abdomen.

Lettering: Epi, pleurite next tergite. Eps, pleurite next sternite. Ovip, ovipositor. S, spiracle. St, gonapophyses (?). Sty, stylets. V-XI, abdominal segments, or tergites 6-9, abdominal segments, or sternites.

PLATE LV.



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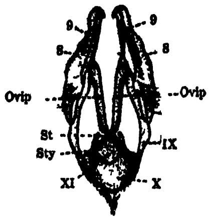

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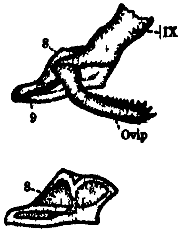

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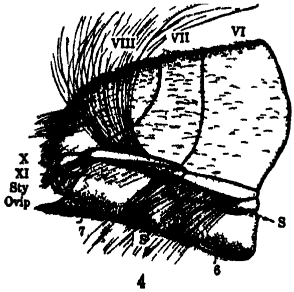

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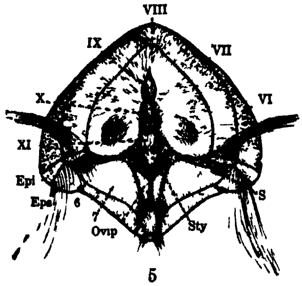

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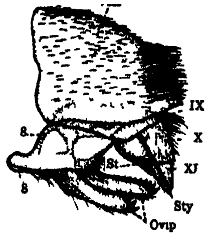

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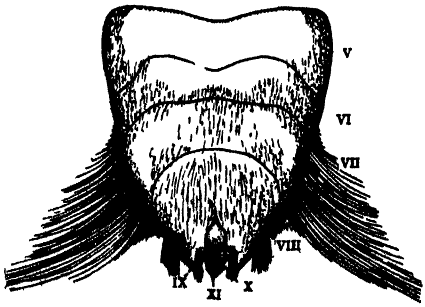

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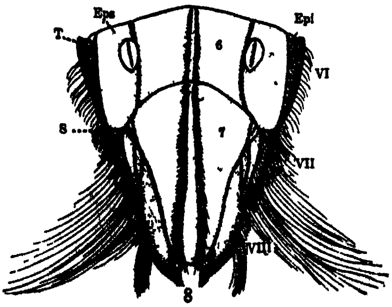

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PLATE LVI

(Oil immersion, balsam.)

Ovipositor of female *B. margaritacea*, outer lateral view. A, teeth on inner mesal surface. B, setaceous hairs of outer lateral surface. C, toothlike spines, outer lateral surface. D, toothlike spines inner mesal surface. I-I′, long outer row of setaceous teeth represented by dashes where seen through other chitin. II-II′, shorter inner row of setaceous teeth represented by lighter thinner lines where seen in section through other chitin. R, row of chitin, may represent ninth abdominal sternite.

PLATE LVI.

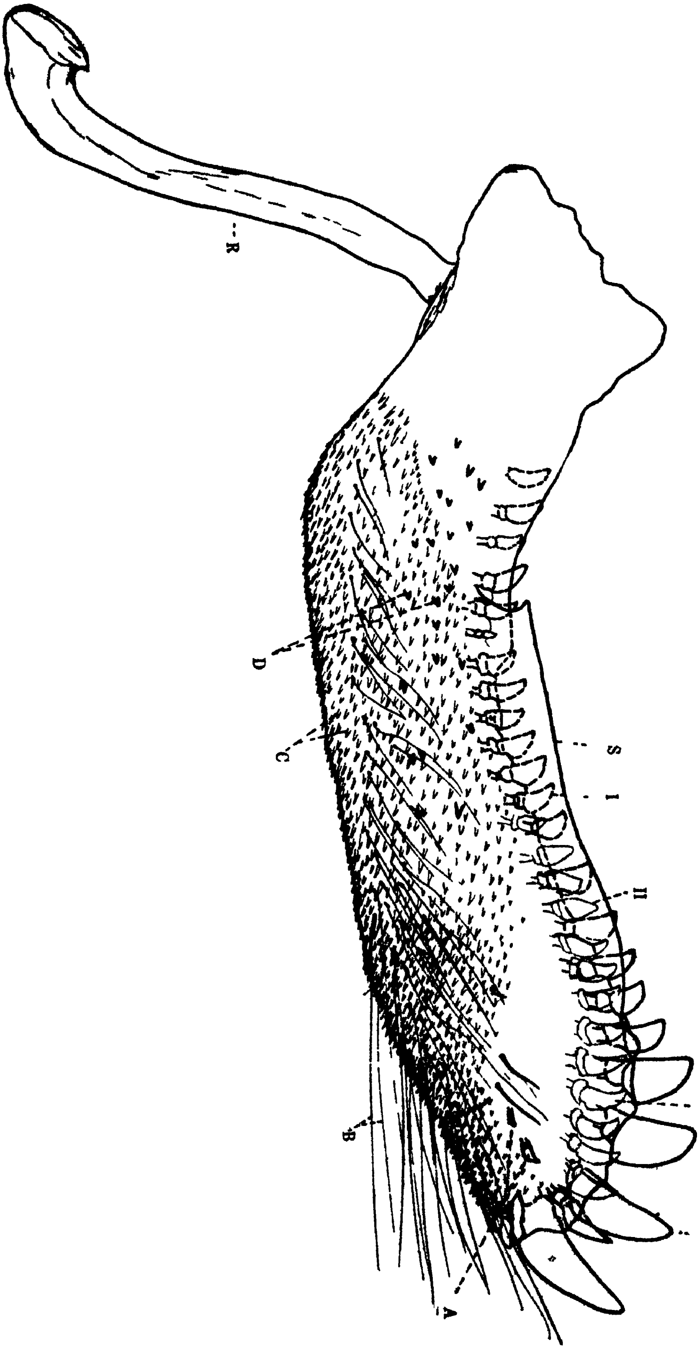


PLATE LVII.

Male and female fifth-instar nymphs, showing genital development.

FIG. 1. Ventral view of male, legs snipped off to allow view of other parts: F, tuft of setaceous hairs, not present in adult. 2, second abdominal spiracle. 7, seventh abdominal sternite. 8, eighth abdominal spiracle, probably nonfunctional.

FIG. 2. Ventral view of female, legs clipped to allow view of other parts: Msc, extension of mesothoracic scutellum (Rich). 7, seventh abdominal sternite.

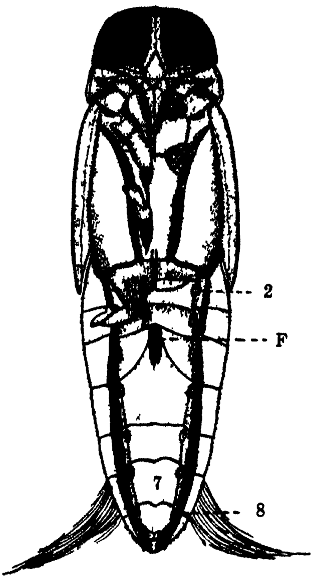
FIG. 3. Ventral view of male tip of abdomen: A, analkonus (Hoppe). 7, seventh sternite. 8, eighth abdominal spiracle. 9, ninth sternite. 10, tenth sternite.

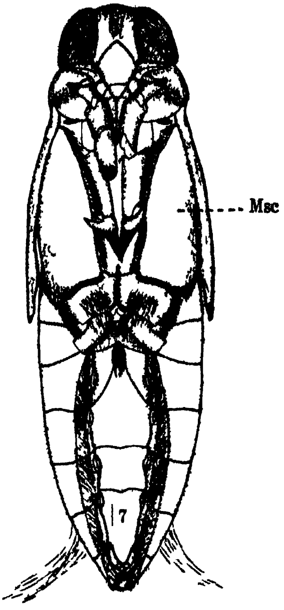
FIG. 4. Ventral view of female tip of abdomen: A, analkonus (Hoppe). a, eighth sternite. b, pleurite. c, ninth ovipositor. d, ovipositor. e, gonapophyses (?). Sty, styli. 7, seventh sternite. 8′, eighth abdominal spiracle. 8t, eighth abdominal tergite.

FIG. 5. Internal development of male genitalia: *Lateral view:* Ed, œdagus. C, clasper. 8 and 9, sternites. *Dorsal view:* C, claspers, Ed, œdagus. 9, ninth sternite. *Tergites*—dorsal view, spread out: 7, 8, 9, tergites of corresponding segments.

FIG. 6. Internal development of female genitalia: Sty, styli. St, gonapophyses (?). Ovip, ovipositors. 8, eighth sternite. IX-XI, tergites.

PLATE LVII.





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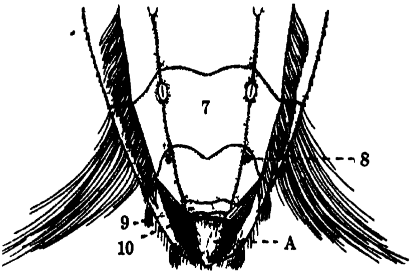

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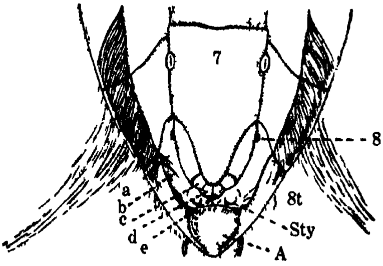

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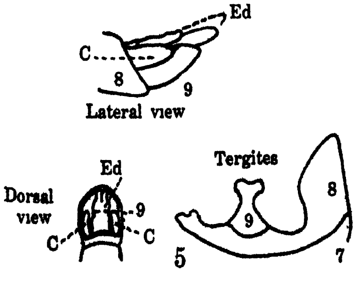

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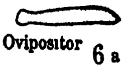

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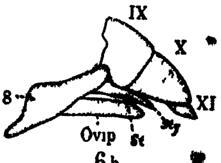

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XVIII.] APRIL, 1928. [No. 4.

An Exploratory Survey of Characters of Specific Value in the Genus *Gelastocoris* Kirkaldy, and Some New Species.

CHAS. H. MARTIN, Department of Entomology

THE Gelastocoridæ or Nerthridæ is a family of squat, toad-shaped bugs that are found frequenting the margins of streams and pools, their color patterns blending with their surroundings so completely that the casual observer rarely ever sees them in their native habitat.

The first species of this family, *G. oculatus*, was described by Fabricius[1] under the family Naucoridæ. Later authors have described species under the names Galgulidæ, Mononychidæ and Gelastocoridæ. Galgulidæ and Gelastocoridæ are the better-known names. This family may be distinguished from the two related families, Ochteridæ and Saldidæ, by the antennæ; the antennæ of Gelastocoridæ being hidden, while those of Ochteridæ and Saldidæ are exposed.

The family contains four genera, all of which, as known at present, are found only in the Western Hemisphere. The genus *Gelastocoris* is represented by the largest number of species, the genus *Mononyx* is represented by several species, while the genera *Nerthra* and *Glossoaspis* each are represented by single species. The following key to the genera has been prepared from literature at hand:

KEY TO GENERA.

A. Fore tarsus with two claws . . . . *Gelastocoris*.
AA. Fore tarsus with one claw.
  B. Wings not fused along median line.
    C. Elytra wholly coriaceous, without clavus or membrane, meeting in a straight sutural line . . . . *Glossoaspis*
    CC. Elytra not wholly coriaceous, overlapping . . . . *Mononyx*.
  BB. Wings fused along median line . . . . *Nerthra*.

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[1] Supplementum Entomologiæ Systematicæ, 1798, p. 525.

THE GENUS *Gelastocoris* Kirkaldy, 1897.

According to a catalogue published by Kirkaldy and Bueno[2] in 1908, this genus embraces ten species. In this catalogue the authors raised all subspecies and submerged species to the rank of species, as the status of some species is somewhat doubtful. In this way all the species are kept before the attention of the worker until the identity of each has been established by the examination of types, or abundant material from type localities. Since this list was published two new species have been described, raising the number to twelve.

Inadequate descriptions accompanying named species, and the bafflingly subtle and elusive characters of the bugs of this genus, have brought about the well-nigh hopeless condition of this group. Mr. J. R. de la Torre Bueno[3], who has been a student of aquatic Hemiptera for many years, has written that "the genus is represented by an uncertain number of undescribed species."

Under the direction of Dr. H. B. Hungerford, who has assembled what is probably the largest collection of *Gelastocoris* known, the author has been able to make a study of considerable material, and from these studies has gained a clear species concept of this difficult genus. It has been possible to find some characters that will aid in more accurately determining a species than has been possible in the past. With this information it is felt that now when a study is made of the old types it will be of more value than it would have been under the present conditions of the taxonomy of *Gelastocoris*.

The author wishes to take the opportunity here to express his most sincere appreciation and thanks to Dr. H. B. Hungerford for his most helpful suggestions and kindly interest in the problem. Thanks are due, also, to Mr. W. S. Blatchley, who has been so kind as to loan paratype specimens of his species, *G. subsimilis;* and to Dr. W. E. Britton for the loan of *G. barberi* Bueno.

The characters that have received special attention in these studies are: The front, the antennæ, the eyes, the metaxyphus, pro-, meso- and metasternum, metasternal orifice, the ovipositors of the females, the granulations on the body surface, the ventral abdominal segments of the males, the thoracic margins, the shape and size of the body, color, and the male genital capsules. These characters fall into three groups: characters of no value, characters of value but difficult to use, and characters of value.

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[2] Kirkaldy, G W., and Bueno, J. R. de la Torre. A catalogue of American Aquatic and Semiaquatic Hemiptera: Proc. Ent. Soc. Wash., Vol. X, Nos. 3, 4, Sept.-Dec., 1908.

[3] Connecticut Geological and Natural History Survey, Bull. 34, 1923, Hemiptera of Connecticut; Family Uerthridæ, pp. 392-396.

CHARACTERS OF NO VALUE.

The shape and slope of the front varies in specimens of the same species. The ridges of the front differ to a certain extent for some species, while for others there seems to be no variation. It has been possible to separate two species from Ecuador by this character; the one species has a transverse ridge across the base of the front, while specimens of the other species are marked by a conelike protuberance. As the genus is so plastic, a long series would probably disprove this character. Such distinct differences do not hold for other species.

Blatchley[4] states that these insects have three or four segmented antennæ, and other authors say that there are four segments in the antennæ. In three species that have been examined, *G. oculatus* (Fabr.), *G. rotundatus* Champ., and *G. quadrimaculatus* (Guer.), five segments are found. A small segment that is not easily seen with ordinary powers of the binocular is between the second and fourth segments and is not always visible with the high powers unless it is put on a wet slide. In some specimens of *G. quadrimaculatus* the second and fourth segments were in such close contact that the third segment could not be found. In the short series studied, the segments varied for different species, especially the fourth. The antennæ have not been considered a character of major importance, so a large series has not been studied.

Some differences exist between the eyes of different species, but as with the front, the differences are not easily measured and have not been considered of much value. In some the eyes are inclined more anteriorly than what might be called normal, while with others the eyes are inclined more posteriorly than normal.

The metaxyphus does differ among species, but the wide variation within a species is so great that this character is not of any appreciable value. The spines on the metaxyphus vary in number along the margin and may or may not be present in the same species. Since the male insects are asymmetrical, this character is not always of the same shape for both sides.

The prothoracic, mesothoracic and metathoracic sternites were studied, and conclusions were reached that they are not good, stable characters by which accurate determinations can be made. The shape varies greatly within a species, and does not differ greatly enough among species to make it a good character. In *G. oculatus*

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[4] Heteroptera or True Bugs of Eastern North America, 1926, pp. 1022-1029.

(Fabr.) the spines on the metasternite varied greatly in number and size. The spines upon specimens from Arizona were sparsely scattered and small, while upon specimens from Kansas they almost covered parts of the metasternite and were larger in size.

The general shape of the metasternal orifice varies in shape within a species. Its position also may be different on different specimens of the same species. The shape of the lips of the orifice is of no value, as drying of the insect would cause their distortion.

An extensive study of the ovipositors of the females has not been made. In some species the spines are very stout, while in others they are smaller and not nearly so stout. An attempt was made to separate species on the arrangement of the spines of the ovipositor, but the pattern varied greatly, and soon the number of groups of spine patterns exceeded the actual number of species.

CHARACTERS OF VALUE BUT DIFFICULT TO USE.

The size and distribution of the granulations on the dorsal region of the body varies some for different species, but they are not of any great value as a character to aid in the determination of a species, because it would be very difficult to describe them. The granulations found on *G. rotundus* (Champ.) are very evenly distributed, giving them an appearance of being smaller than they actually are. With most species they are uneven in size and distribution.

The shape of the ventral abdominal segments offers an external character for separating males that might be used as an auxiliary character. This character was fairly constant in the series examined. The telescoping of the abdomen will vary for a species, and is not a very good specific character. The last caudal segments vary in shape and length for different species. The main difficulty that presents itself in the use of this character is that the segments may shift their positions so that the general aspect of the segments is changed, and thus at times becomes misleading. The position of the spiracles on the last segments is of no value. In some species they are found with difficulty. For some species the posterior spiracle shifts its position because the segment it is upon shifts its position. The spiracle opposite this one has not been found.

CHARACTERS OF VALUE.

The margins of the prothorax differ strikingly enough among species that it is considered as a good character. The margins show a great range of variation within a species, but once a characteristic shape is learned with its variations, a species may be usually determined quite easily. The slope of the disc of the thorax is not considered as a character of any importance.

The color of these insects is helpful in determining most species; however, it cannot be relied upon as an accurate check. Possibly *G. oculatus* (Fabr.) shows as great a range of color as any of the species described. We give notes on color under the discussion of the species.

The size and shape of the body are gross indicators of a species. Some species show a great range in size and shape, while with others these characters were fairly constant in the series examined. The length of *G. quadrimaculatus* (Guer.) ranged from 5.29 mm. to 6.46 mm. for a series of males. This species is very unstable morphologically. The measurements given in the descriptions at the end of this paper for the length of the body are taken from the anterior margin of the pronotum to the tip of the wings. The slope of the front depends in part upon the position of the head, so it does not offer a stable point from which to measure.

Hungerford[5] suggested that the genitalia of the male might be of value in helping to distinguish one species from another. As was predicted, studies of the genitalia of the male were very fruitful. To aid in these studies long, narrow trays of plaster of Paris were made with partitions in which to keep the individual genitalia separate, yet conveniently placed for comparative study. With these trays it was possible to have a long series ready for immediate comparison without any danger of mixing the specimens. It was found that structures could be studied more carefully if the capsule were left to dry. However, when it was desired to make studies under water, the tray would be filled with water and placed in a small dish in which water was poured until the tray was not quite submerged. In this way water could be added from time to time without disturbing the contents of the tray.

The genitalia were dissected by holding the relaxed insect between the thumb and forefinger while a curved dissecting needle was inserted along the side of the capsule and then carefully worked around the anterior edge of the bulb, breaking the membrane loose from the body wall. After this had been done the chitinized capsule could be pulled out quite easily and either kept in a small vial of alcohol, numbered with the specimen, or mounted on a point, the point being kept with the specimen.

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[5] Kan Univ Sci. Bul, Dec, 1919, Ent No The Male Genitalia as Characters of Specific Value in Certain Cryptocera (Hemiptera-Heteroptera), pp 329-331; Pl. XXI, Figs 5 and 7, pp 334, 335

The caudal segments of the male have made a quarter turn to the right so that the tips of the claspers point to the right instead of dorsally. In most insects both claspers are equally developed, but in this group the left clasper is much reduced, and has a ventral position in respect to the insect. It is more or less strap-shaped, the shape varying some in a few species.

To aid in the description of the genital parts the nomenclature employed by Hungerford[6] has been used, namely: left clasper, right clasper, and distal angle of the right clasper. The following have been arbitrarily added: right clasper hook, tip of right clasper hook, bulb, keel, keel hood, pan, and secondary pan. (See Pl. LIX, Fig. 18.)

The left clasper has already been discussed. For the sake of comparison the right clasper can be likened to a capital letter "J" made backwards, in both shape and position. Along its anterior lateral margin rows and patches of peglike structures are found. The number of these structures or their distribution pattern seems to be of no special value as a specific character. The caudal margin of the right clasper is produced into a flat plate which bears a curved, fingerlike process that has been termed the right clasper hook. (Pl. LIX, Figs. 18 and 19.) The wide range of variations of the right clasper hook make it useless as a specific character.

The angle formed by the right clasper hook and the lateral margin of the clasper has been termed the distal angle. This angle has no value as a character for determining a species. (See Pl. LIX, Fig. 20.) The plate at the end of this paper shows the wide range of variation of this angle in *G. oculatus* (Fabr.).

The tip of the right clasper is not a very good character, since it is not always of the same length and shape within a species. Though the shape of the bulb does differ among species, it is believed that it is of little use taxonomically. The posterior arm of the bulb, which has been termed the keel, bears characters that can be depended upon as an aid in accurately determining a species. The hook on the distal end of the keel (the keel hook) has a characteristic shape for each species that possesses it. In some species there is quite a range of variation in the size of this hook. In the species *G. quadrimaculatus* (Guer.) the size and shape might be quite misleading unless one is familiar with the species. Some species are without a keel hook. The reader is referred to the plates at the end of this paper for the shapes of different species.

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[6] See footnote 5.

The shape of the keel hook aids in the determination of a species. It is normally placed on the ventral side of the keel, with respect to the insect, but in some species it may be displaced laterally. A secondary keel hood appears in *G. cucullatus* n. sp.

The shape of the pan is an indication of a species. (See Pl. LIX, Fig. 18.) Upon the pan is a small structure that we have termed the secondary pan. It is not of much value as a character.

CONCLUSION.

From the above studies one can draw the following points, which are the only ones of significance in determining a species: The genitalia of the male supply certain stable characters, as do also the lateral margins of the prothroax of both male and female, and the ventro-caudal segments of the abdomen of the male, with due regard for the range of variation of each specific character. The combination of the structural features mentioned above may be relied upon to differentiate the species in this exceedingly difficult genus.

Gelastocoris oculatus (Fabr.).

Naucoris oculata Fabricius; 1798. Ent. Syst., Suppl., p. 525.
Galgulus oculatus (Fabr.) Latreille; 1802. Hist. Nat. Crust. Ins., III, p. 254.
Gelastocoris oculatus (Fabr.) Kirkaldy; 1897. Entomologist, XXX, p. 258 (n. n. for *Galgulus* Latr.).
Gelastocoris barberi Bueno; 1928. Conn. Nat. Hist. Survey Bul. 34, p. 393, Fig. 38.
Gelastocoris subsimilis Blatchley; 1926. Heteroptera of Eastern North America. The Nature Publishing Co., Indianapolis, Ind., p. 1025.

Fabricius' original description, translated, is as follows:

"Margin of abdomen supplied above with black, anterior feet two-clawed.

"Habitat: in Carolina.

"Closely related to *N. nepaeformi* but distinctly different. Head small with boldly prominent eyes, ring of eyes ovate, subspinose. Thorax flat. black. Elytra black, immaculate. Anterior feet scarcely incrassate, tibia elongate, tip of foot, incurved, claws incurved, sharp, stout."

Thoracic margins, plate LVIII, Figs. 9, 10, 11, 12, 13. Genitalia of male, plate LIX, Figs. 1 2 and 3. Length: Male, 4.4 mm. to 7 mm.; female, 6.3 mm. to 8.1 m.

This is the only species of this genus found in the United States with the exception of *G. rotundatus* Champ., found in Arizona; *G. vicinus* Champ., which Champion says inhabits the Southern and Western states; and according to Van Duzee, *G. variegatus* (G.) in the Western states. We have at hand 550 specimens of this insect collected in the Atlantic Coast, Southern, Central, Southwestern, and Pacific Coast states. It is a species that shows a great

range of variation in morphological characters and in color variation. Our plate LVIII, figures 9, 10, 11, 12 and 13, show some of the variations of the thorax. It will be noted that there are no two alike, but all have the same general appearance. Other variations of the surface and shape of the sternites and other body structures have been mentioned elsewhere in this paper.

The genitalia of the male show many individual variations. Plate LIX, figure 20, shows a series of distal angles (the distal angle is found on the right clasper). It will be noted that there is a gradual gradation from the oblique angle to the acute angle, proving beyond doubt that the angle is only an individual variation and not a specific difference. The keel hood, the keel hook, the pan, and the secondary pan show a great deal of variation. However, when everything is taken into consideration, all the genitalia are of the same general type as shown on plate LIX, figures 1, 2 and 3.

G. oculatus (Fabr.) shows the greatest variation of color of any of the described species that we have at hand. When groups of individuals are considered, several color varieties might be described. But when the whole group of specimens at hand are taken into consideration, it is seen that there is a gradation from one color to another. The genitalia of the males are all of the same type, so they are not different species; possibly good ecological species, but they are not good taxonomic species. Specimens from Florida and North Carolina have a ground color of brown or dark brown, almost black in some specimens, variegated with light-colored granules. Other specimens from North Carolina, Tennessee, Louisiana, Arkansas, Texas, Kansas, Missouri, Nebraska, Arizona and Oregon range from a black to a light grey, and from a dark brown to a light tan for the ground color. The granules are, for the most part, some shade of white. The arrangement of the large and small granules makes a variegated pattern on the ground color. Some are strikingly variegated, while others are more obscurely variegated. Some particular specimens from central Kansas and Texas have the medial area of the dorsal region of a dark reddish-brown color, while the lateral margins are splashed with yellow. In some specimens a tinge of lilac appears where the yellow and brown blends. With some specimens from western Kansas the dorsal surface is from a gray to a bright black, spotted with a yellowish-white, the white color being tinged with pink. The pronotum is mottled with shades of brown and spotted with yellowish-white tinged with pink. The specimens are indeed colorful and vie with Guerin's *G. variegatus* in beauty. Other specimens from this region and from Oregon are of a velvety brown with white granules. As mentioned before with other specimens the arrangement of the granules gives a variegated effect. These are also very handsome specimens, and have been determined erroneously as *G. variegatus* (Guer.). A male from Arizona and a female from Oregon are marked with various shades of tan and red. The base of the pronotum is a light-green color. Other specimens show other color schemes.

Van Duzee[7] gives the following locality records: New York, New Jersey, Pennsylvania, Maryland, District of Columbia, "Carolina," Georgia, Florida, North Carolina, Ohio, Illinois, Minnesota, Colorado, Oklahoma, Arizona. To which list we add the following records: Tennessee, Louisiana, Missouri, Arkansas, Kansas, Nebraska, Texas, California and Oregon. This is the first time, to the best of our knowledge, that this species has been reported from the Pacific coast. The following records are from Kansas: Douglas county, H. B. Hungerford, collector; Bourbon county, R. H. Beamer, collector; Woodson county, R. H. Beamer, collector; Neosho county, Mrs. Grace Wiley, collector; Labette county, R. H. Beamer, collector; Cherokee county, H. B. Hungerford and R. H. Beamer, collectors; Riley county, J. B. Norton, collector; Saline county, C. H. Martin, collector; Ellsworth county, C. H. Martin, collector; Rice county, C. H. Martin, and others, collectors; Reno and Barton counties, Cavanaugh, collector; Pawnee, Meade and Comanche counties, C. O. Bare, collector; Morton county, C. O. Bare and others. collectors; Wallace, Logan, Norton, Graham and Rooks counties, F. X. Williams, collector. From these records we see that this insect inhabits all parts of Kansas.

SPECIES IN SYNONYMY.

Gelastocoris barberi Bueno. Through the kindly interest of Dr. H. B. Hungerford and the generosity of Dr. W. E. Britton I have been permitted to examine the type specimen of this species. The collections of the University of Kansas contain a series of specimens from Kansas and Texas that are similar. These specimens are all *G. oculatus* (Fabr.). *Gelastocoris barberi* Bueno is a synonym of *G. oculatus* (Fabr.).

Gelastocoris subsimilis Blatchley. We had two specimens of this insect, one collected at LaBell, Fla., by D M. DeLong, and one collected at Hertford, N. C., by W. R. Walton, which we identified as *G. subsimilis* Blatch. Later we were able to verify the identification with a male and a female paratype loaned by Mr. Blatchley. Fortunately, at the time Mr. Blatchley's paratypes were in our hands, Mr. C. O. Bare sent in a series of 17 males and 20 females collected in Florida which were identical with Blatchley's paratypes. A comparison of the thoracic margins (Pl. LVIII, Figs. 9 and 11) with those of *G. oculatus* (Fabr.) (Pl. LVIII, Figs. 10, 12 and 13), show that the thoracic margins of *G. subsimilis* are of the type of those of *G. oculatus*. When the color patterns were studied it was found that they were also the same as for *G. oculatus* from other localities. While the males are smaller than the males from other localities, yet their genitalia (Pl. LIX, Fig. 1), are the same size and the same type as those of males from other localities. (Pl. LIX, Fig. 2, 3.) Taking the thoracic margins and color patterns in consideration and using the genitalia of the male as final proof of our assertion, *Gelastocoris subsimilis* Blatchley is a synonym of *Gelastocoris oculatus* (Fabr.).

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[7] Van Duzee, E. P. Cat. of the Hemiptera of America North of Mexico. . . . Univ of Calif. Pub. Tech. Bul., College of Agri, Agricultural Experiment Sta, Ent. Vol. I, 1917, p. 472.

Gelastocoris bufo (H-S.).

Galgulus bufo Herrick-Shaffer, 1839 or 1840 (?). Die Wansenartigen Insekten; V, p. 88, Pl. 174, Fig 536.

His original description is as follows:

"G. fuscescens, subtus pallidior, tibis et tarsis posterioribus pallidis fusco annulatis.

"Da ich dieseinzige Art dieser Gattung vor mir habe, so kann ich nicht mit Bestimmtheit behaupten, ob es wirklich Lefebvre's bufo ist. *G. oculatus* (F.) kann es nicht wohl sein weil hier der Bauch schwarz sein soll.

"Gestalt kurz eiförmig, unten flach, oben wenig convex; die Oberfläche durch äusserst feine Korchen chagrinartig, matt rötlich graubraun, gegen die Spite der Decken mehr rotbraun. Kopf, Thorax, und Schildehen durch ziemlich unregelmässige Erhöhungen uneben; die Wurzelhlfte der Decken braun und grau sehr zierlich gewässert, die schmale Membran schmutzig weiss. Unten blässbraun, mit lichen Rändern aller Theile. Auch die Flügel sind bis über die Zellun hinaus braun, und nur an der Spitze weiss.

"Aus Amerika; ohne genauere Angabe von Herr Norwich in Bremen."

Thoracic margins, plate LVIII, figure 14. Length: Male, 6.98 mm.; female, 7.43 mm. to 7.65 mm.

We have at hand one male identified by Champion, who collected it at Guatemala City. The genitalia of the male have been removed by someone in the past, so we are not able to figure them. The thoracic margins are very characteristic. The specimens are of a mottled reddish-brown color.

Champion gives the localities Mexico, Guatemala and Costa Rica as its habitat. Our specimens are from these localities.

Gelastocoris flavus (Guerin).

Galgulus flavus Guerin, 1844, Iconographie du Regne Animal de B. Cuvier per Felix Edouard Guerin-Meneville. Tome (II, III or IV [?]), pp. 251-255.

Guerin's original description translated is as follows:

Entirely of a dirty yellowish-russet, shading to brown; underneath more pale, some small, smooth tubercles, green and yellow, on elytra. Posterior legs faintly ringed with brown. Length, 7 mm.; width, 5 mm.

"Figures 4*a*, its large head and view of face; 4*b*, antennæ.

"Habitat: The interior of Brazil.

"Notes: This species is very closely related with *Galgulus bufo* of Hahn."

We possess three males and three females of this species. Some of the males are above and below of a lurid red, concolorous; others dark yellow and black in color. The wings of the females are shorter than the abdomen. One female is of a dull red while the other two are of a reddish-brown. Both males and females possess six short, longitudinal carina on the base of the pronotum that may be faint or prominent. Some specimens have the lateral edges of the pronotum broadly crenate. The specimens at hand do not possess the green tubercles that Guerin mentions, but such colored tubercles have no particular significance, and may or may not be present.

Guerin's figure shows that the insect that he had had the base of the pronotum straight. In our specimens it is arcuate. Champion mentions that with his species the base of the pronotum is trisinuate. Our studies of the bases of other species show that they are very variable, and it is very probable that this species shows an even greater variation than in the species we have seen.

Thoracic margins, plate LVIII, figure 18. Male genitalia, plate LIX, figures 4, 5 and 6.

Champion gives as the habitat, Costa Rica, South America, to Peru and Bolivia. Our specimens are from Brazil, Bolivia and Paraguay. We believe that possibly the females that we have at hand are the only ones of this species that have been seen.

Gelastocoris quadrimaculatus (Guerin).

Galgulus quadrimaculatus Guerin; 1844. Icon. Ins., p. 351.
Galgulus nebulosus Guerin; 1844 Icon Ins., p. 351.
Galgulus nebulosus var. *b* Stal; 1876. Svenk. Vet.-Ak. Handl. Enumeratio Hemipterorum, 14, No. 4, p. 137.
Gelastocoris stali Kirkaldy and Bueno; 1908. A Catalogue of American Aquatic and Semi-aquatic Hemiptera. Proc. Ent. Soc. Wash., Vol. X, Nos. 3 and 4, Sept. to Dec., 1908.

His original description translated is as follows:

"Upper part black or very dark brown, with the head and sides of the prothorax, some little spots on the scutellum, and one spot on each side at the back, on the posterior edge of the elytra, of yellowish russet. Some small green and very smooth tubercles on the elytra. Underneath and the legs yellow, with the base of the abdomen black, and the sides alternately black and brown. Posterior legs ringed with brown. Length, 7 mm; Width, 5 mm.

"From Brazil and Bolivia."

Thoracic margins, plate LVIII, figures 1, 2, 3, 4, and 5. Male genitalia, plate LIX, figures 14, 15 and 16. Length: male, 5.29 mm. to 6.45 mm.; female, 5.18 mm. to 6.88 mm. It will be noted that our measurements fall shy of Guerin's. However, it must be remembered that our measurements do not include the head of the insect.

We have in the collections 62 females and 52 males from Bolivia, Paraguay, Brazil and Ecuador. The species show a great variation in size and otherwise morphologically. Even the male genitalia show extreme differences in size, and also differences of structure. However, all are of the same general type, and all the specimens at hand are considered to be the same species. Some species are of a buff or tan color with or without green tubercles; others are fuscus with or without green tubercles. One specimen is mottled with a lurid red on a buff-colored background. Other specimens have the median part of the dorsal region black, while on each side of the black stripe it is buff or tan.

SPECIES IN SYNONYMY.

Stal reduced *G. quadrimaculatus* to a variety under *G. nebulosus*, and then described his variety *b* under *G. nebulosus* (G.). Following the Zoölogical

Code, *G. quadrimaculatus* takes precedence over *G. nebulosus*, as it was described before *G. nebulosus* in the paper. Because of the wide variation exhibited by this species and from the study of the genitalia and color of our specimens, we believe that Guerin described the same insect under two names, his G. *nebulosus* being different only in coloration, which is not a good character for most species in this genus. Both species come from the same countries. Stal's *G. nebulosus* var. *b* is very evidently just another color variation of the species. As Kirkaldy and Beuno raised Stal's variety to a species it will fall.

Gelastocoris variegatus (Guerin).

Galgulus variegatus Guerin; 1844. Icon. Ins. p. 352.

Guerin's description translated is as follows:

"Above a variation of dark brown, of black, of gray more or less whitish, and of yellow. The gray forms some round spots surrounded with deep black; some very small, smooth, ivory white tubercles on the elytra. Underneath black with the sides of the thorax spotted with white and that of the ventral with russet. All the legs banded with dark brown and russet. Length, 6 mm. to 7 mm.; width, 4½ mm. to 5 mm. From the Bay of Campeche. Taken by M. Perbose, surgeon of the Royal Marine at Toulon."

Thoracic margins, plate LVIII, figure 8. Male genitalia, plate LIX, figure 10.

The thoracic margins of this insect are very distinct. In Champion's words, "the pronotum is subparallel at the sides in front. The lateral angles are foliaceous, very distinctly crenate in front and behind, and transverse or subtransverse along their anterior edge." As with other species, there is a variation in the color of different specimens. Champion gives as its habitat North America, southern and southwestern United States; Costa Rica; Argentina; Antilles; Cuba; and Panama. Our specimens are from Guatemala and Mexico.

Gelastocoris pulcher (Stal).

Galgulus pulcher Stal.; 1854. Ofversigt af Kongliga Vet.-Ak. Forhundlingar. Stockholm, XI, p. 239.

Stal's original description translated is as follows:

"1. *G. pulcher:* Very densely coarsely granulate, brown and white wavy variegated, thorax convex, flat, subimpressed transversely, last part and base angularly dilated; scutellum trituberculate; exterior margin of clavus becoming reddish; blackish underneath, variegated with white; legs whitish, ringed with brown. Length, 7 mm.; width, 5 mm. Habitat: Mexico."

Champion placed this species in synonymy under *G. oculatus* (Fabr.). The description suggests Herrick-Shäffer's colored figure of his *G. bufo.*

Gelastocoris vicinus Champion.

Gelastocoris vicinus Champion; 1901. Biologia Centrali-Americana, Insecta Rhynchota. Hemiptera-Heteroptera, Vol. II, by G. C. Champion, F. Z. S.; 1897-1901, p. 349.

Champion's original published notes are as follows:

"Montandon has sent us for examination numerous specimens of this insect from Costa Rica, and also one from Mexico, and we have many others from Nicaragua and Chiriqui agreeing with them. It is very much like *G. variegatus,* but has the foliaceous lateral angles of the pronotum more oblique in front (instead of transverse) and less coarsely crenate. The pronotum is strongly constricted at the sides behind the anterior angles, the margins being subparallel in front. The general coloration is usually more obscure than in *variegatus*. *G. vicinus* is the only species of the genus found by myself at elevations above 2,500 feet on the slope of the Volcan de Chiriqui.

"Habitat: North America, southern and western United States; Mexico; Panama; South America to Brasil."

Thoracic margins, plate LVIII, figure 7. Male genitalia, plate LIX, figure 9. Length, 6.3 mm.

We possess two specimens collected at R. Surnbres, San Mateo, C. R., altitude 250 m., February, 1905.

Gelastocoris rotundatus Champion.

Gelastocoris rotundatus Champion; 1901 Biologia Centrali-Americana, Insecta Rhynchota. Hemiptera-Heteroptera, Vol II By G C Champion, F. Z S, 1897-1901, p. 347; Pl. 20, Fig. 18

Champion's original published notes are as follows:

"Of this species we possess about a dozen examples, agreeing with the types communicated by M. Montandon. It is nearly allied to *G. oculatus* (Fabr.), but differs from that insect in having the pronotum broadly rounded at the sides and feebly sinuate behind the anterior obtuse angles. In one of the specimens from Pinos Altos the entire upper surface is mottled with reddish brown. *G. rotundatus* will almost certainly inhabit the southern part of the United States. A spotted example from Guatemala City is figured.

"Habitat: Mexico; Guatemala."

Probably Champion never intended that this species and *G. vicinus* Champion should be credited to him. As no other descriptions of these species can be found that were published before Champion's, his description's are taken to be the original descriptions.

Thoracic margins, plate LVIII, figure 16. Male genitalia, plate LIX, figure 8. Length: Male, 6.95 mm. to 7.0 mm.; female, 7.2 mm. to 7.3 mm.

We have at hand 14 specimens, most of which are mottled with reddish brown; one is black mottled with tan. Two of our specimens were collected at Douglas, Ariz., August, by F. H. Snow, which is the first time that a record for this species from the United States has been published.

Gelastocoris cucullatus n. sp.

Length: Male, 4.96 to 5.40 mm.; female, 5.85 mm.

A species near *G. variegatus* (Guer.) and *G. vicinus* Champion. Does not possess the transverse lateral margins of the thorax of *G. variegatus*, and is of an ovate shape instead of the elongate shape of *G. vicinus*.

COLOR. Ground color of males black to different shades of brown. Some specimens strikingly marked with patterns of yellowish-white, others more obscurely marked. Three specimens at hand have the color and markings of *G. variegatus*. Some females are black, streaked with brown, others are brown, marked with darker brown.

MARGINS OF THORAX. Plate LVIII, figure 6. Posterior angle more broadly rounded than that of *G. vicinus*.

GENITALIA OF MALE. Plate LIX, figures 11, 12 and 13. The angle found on the margin of the keel hood and the secondary hood beneath the keel hood, which may or may not reach the dorsal edge of the keel hook, are characteristic structures of the genitalia of the male.

Described from 4 males collected at Los Amates, Guatemala, by Kellerman; 1 male collected at Guatemala City, by Champion (det. by him as *G. oculatus*); 1 male, no locality record, marked O. Sacken; a male and a female collected at Canal Zone, Barro, Colorado, by N. Banks; 1 female collected at Penemoma, Panama, by H. Brown; 1 male collected at Gualan, Guatemala, April 1, 1905. Holotype, male (Guat.), allotype (Pan.) female and 3 paratypes deposited in the entomological collections of the University of Kansas; 1 paratype deposited in the Carnegie Museum; 1 paratype deposited in the American Natural History Museum.

Gelastocoris fuscus n. sp.

Length: Males, 6.3 mm. to 7.2 mm.; females, 6.75 mm. to 7.43 mm.

Resemble *G. bufo* (H-S.) but with the lateral margins of the pronotum more deeply constricted.

COLOR. Color generally fuscous, some black present. With some specimens the pronotum is of a lighter color than the rest of dorsal region.

MARGINS OF THORAX. Plate LVIII, figure 15. Lateral margins of thorax more or less crenate. Posterior angle may be sharp or rounded. Considerable variation is found among individual specimens.

GENITALIA OF MALE. Plate LIX, figure 17. Instead of a keel hook a flaplike structure is present.

Described from 5 specimens collected at Tena, Ecuador, February 23 and 28, 1923, by F. X. Williams; 1 male collected at S. Paulo Olivonca, Brazil, by S. Klages; 1 female collected at Banos, Ecuador, June 22, 1923, by F. X. Williams; 1 female collected near Napo, Ecuador, February 14, 1923, by F. X. Williams. Holotype, male (Ecuador), allotype, female (Ecuador) and 5 paratypes deposited in the entomological collections of the University of Kansas; 1 male paratype (Brazil), deposited in the Carnegie Museum, Philadelphia.

Gelastocoris duplicatus n. sp.

Length: Male, 5.85 mm.; female, 6.75 mm.

It is difficult to distinguish this species form *G. fuscus* n. sp. The shape of the body for the specimens that we have is somewhat different from that of *G. fuscus*. Also the posterior margin of the posterior angle of the margins of the pronotum is more nearly subparallel than those of *G. fuscus*. The genitalia of the male is very strikingly different from that of *G. fuscus*.

COLOR. Dorsal region from black to dark brown, nearly concolorous; ventrally fuscus. Base of pronotum greenish yellow to orange; disk, ground-color black, with greenish granulations, prominent orange spots on the disk of the specimen at hand. Females with more black in ground color than male, granulations tan color, pronotum tan and black.

MARGINS OF THORAX. Plate LVIII, figure 17. Margins of thorax most nearly resembles those of *G. vicinus* Champion and *G. quadrimaculatus* (Guer.)

GENITALIA OF MALE. Plate LIX, figure 7. Genitalia with a very robust, double keel hook and a double pan.

Described from a male and a female collected at Naranjapta, Ecuador, 1,850 feet, December 14, 1923, by F. X. Williams. Holotype male, allotype female, deposited in the Entomological Collections of the University of Kansas.

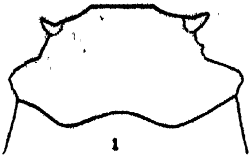
EXPLANATION OF PLATES.

PLATE LVIII.

Thoracic margins of *Gelastocoris.*

Figs. 1, 2, 3, 4, 5. *Gelastocoris quadrimaculatus* (Guer.).
Fig. 6. *Gelastocoris cucullatus* n. sp.
Fig. 7. *Gelastocoris vicinus* Champion.
Fig. 8. *Gelastocoris variegatus* (Guer.).
Figs. 9, 10, 11, 12, 13. *Gelastocoris oculatus* (Fabr.).
Fig. 9. Specimen from Florida. A specimen of *G. subsimilis* Blatchley, in synonymy.
Fig. 10. Specimen from Arizona.
Fig. 11. Specimen from Florida. Drawn from a paratype specimen of *G. subsimilis* Blatch., species in synonymy.
Fig. 12. Specimen from western Kansas.
Fig. 13. Specimen from North Carolina.
Fig. 14. *Gelastocoris bufo* (H-S).
Fig. 15. *Gelastocoris fuscus* n. sp.
Fig. 16. *Gelastocoris rotundatus* Champion.
Fig. 17. *Gelastocoris duplicatus* n. sp.
Fig. 18. *Gelastocoris flavus* (Guer.).

PLATE LVIII.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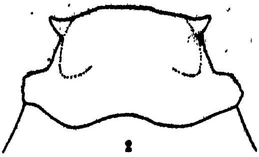
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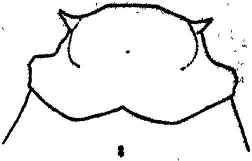
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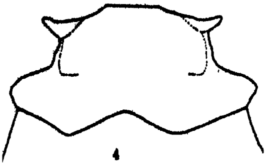
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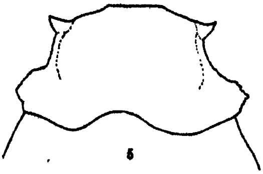
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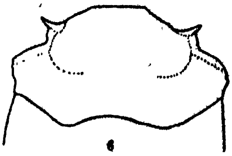
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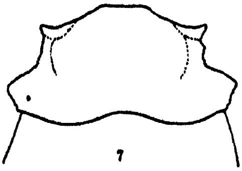
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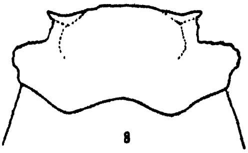
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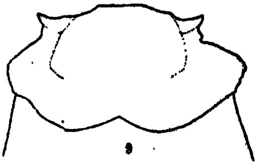
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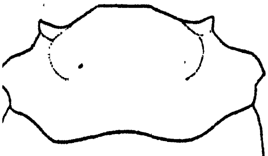
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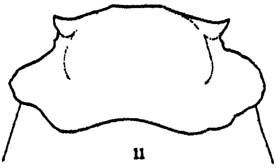
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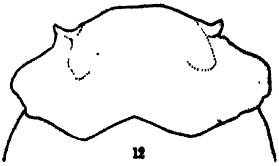
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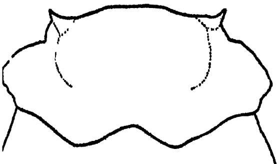
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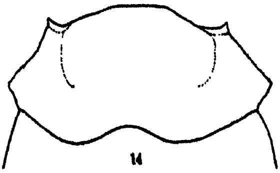
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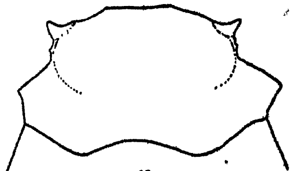
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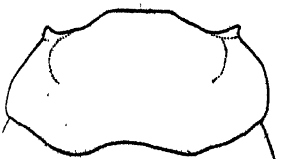
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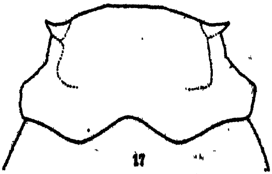
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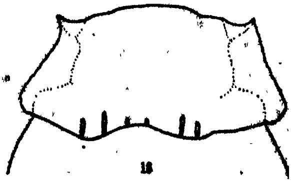
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PLATE LIX.

Male genitalia of *Gelastocoris*.

FIG. 1. *Gelastocoris oculatus* (Fabr.). Drawn from a specimen of Blatchley's *G. subsimilis*.

FIGS. 2, 3. *Gelastocoris oculatus* (Fabr.).

FIGS. 4, 5 and 6. *Gelastocoris flavus* (Guerin).

FIG. 7. *Gelastocoris duplicatus* n. sp.

FIG. 8. *Gelastocoris rotundatus* Champion.

FIG. 9. *Gelastocoris vicinus* Champion.

FIG. 10. *Gelastocoris variegatus* (Guer.).

FIGS. 11, 12, and 13. *Gelastocoris cucullatus* n. sp. A, keel hood. B, Secondary keel-hood.

FIGS. 14, 15 and 16. *Gelastocoris quadrimaculatus* (Guer.).

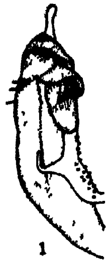
FIG. 17. *Gelastocoris fuscus* n. sp.

FIG. 18. Male genitalia of *G. oculatus* (Fabr.).

FIG. 19. A and B, right clasper hooks of *G. fuscus* n. sp. C and D, right clasper hooks of *G. oculatus* (Fabr.). E and F, right clasper hooks of *G. rotundatus* Champ. These figures illustrate the wide variation that is found within the same species.

FIG. 20. Distal angles of *G. oculatus* (Fabr.).
20*a,* Riley county, Kansas.
20*b,* Cherokee county, Kansas.
20*c,* North Carolina.
20*d,* Colorado county, Texas.
20*e,* Douglas county, Kansas.
20*f,* Ellsworth county, Kansas.
20*g,* Morton county, Kansas.
20*h,* Austin, Texas.
20*i,* Bourbon county, Kansas.
20*j,* Comanche county, Kansas.
20*k,* Arizona.
20*l,* Tucson, Ariz.
20*m,* Pawnee county, Kansas.

PLATE LIX.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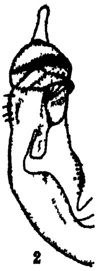
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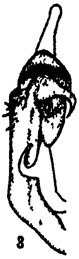
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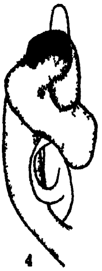
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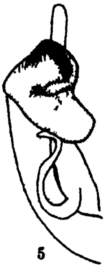
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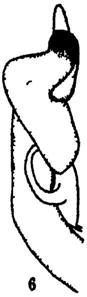
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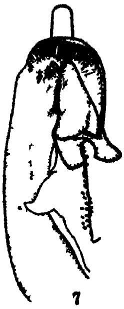
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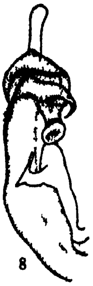
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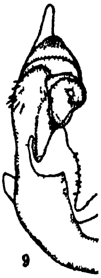
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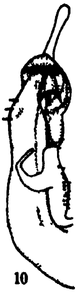
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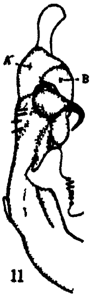

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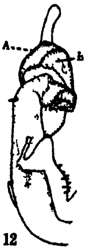

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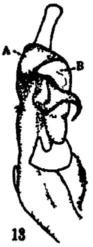

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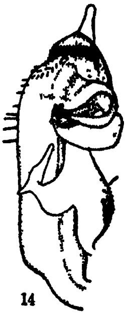
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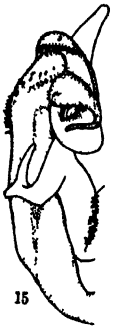
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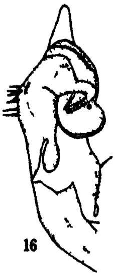
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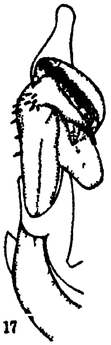
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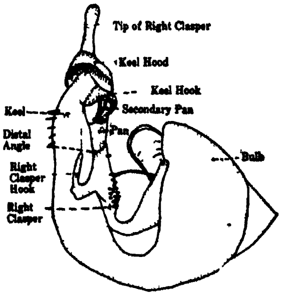

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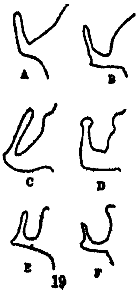

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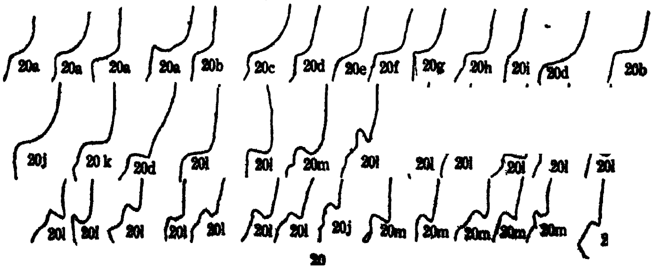

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XVIII.] APRIL, 1928. [No. 5.

The Coreidæ of Kansas.*

HOWARD OWEN DEAY, Department of Entomology.

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INTRODUCTION.

THE purposes of this paper are: (1) to give a list of the species of Coreidæ that have been taken in Kansas to date; (2) to give the counties in which they have been collected; (3) to give the original description of each species found and to give any further characteristics which may aid in the determination of the species; (4) to determine whether the genital capsule and claspers of the male have specific value; (5) to make keys for the separation of the groups down to species.

The material examined is in the Snow entomological collection at the University of Kansas, Lawrence, and in the entomological collection at the Kansas State Agricultural College, Manhattan. The material in the Snow collection is an accumulation of years of collecting by the members of the State University Biological Survey.

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* Submitted to the Department of Entomology and the faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

Collections have been made in nearly every county in the state. However, most of these surveys were made in the months of June, July and August and, as the Coreidæ as a rule are more numerous in the autumn, it is likely that the distribution of the different species is more extensive than the records show.

The writer wishes to express his appreciation to Dr. H. B. Hungerford, under whose direction the work was done and who gave most helpful advice and criticism; to Prof. Harry G. Barber, of Roselle, N. J., who checked the writer's identifications; to Dr. P. A. Readio and Kathleen C. Doering, for their kindly help and criticism; and to all others who in any way have assisted in this work.

FAMILY COREIDÆ.

The members of this family vary greatly in form. Some of the species are among the largest of the Hemiptera, and others are very small and inconspicuous; some have peculiar expansions or shapes of the tibiæ or antennæ; in some the femora are swollen or armed, or both; and in some the hind coxæ are widely separated, while in others they are contiguous.

The family is characterized as follows: The antennæ are situated above an imaginary line drawn from the eye to the base of the rostrum, and are four-segmented; the vertex of the head is not transversely impressed; the rostrum is four-segmented; the scutellum is triangular and of small or medium size, not reaching the middle of the body; the hemelytra are usually complete and composed of clavus, corium and membrane; the membrane is furnished with numerous veins which spring from a transverse basal vein, and are more or less anastomosing; the tarsi are three-segmented; the ocelli are present.

In the male the last ventral segment is modified to form a secondary sexual organ, the genital capsule. It bears a pair of clasping organs, the claspers, which are attached to the surface, and are concealed in the genital capsule in the members of three of the subfamilies (Merocorinæ, Coreinæ and Pseudophlœinæ).

The species of the family found in Kansas fall into three groups when classified by the genital capsule of the male. The males of the subfamily Coreinæ (Pl. LX, Fig. 5), Merocorinæ (Pl. LX, Fig. 4), and Pseudophlœinæ (Pl. LXII, Fig. 1) have a single convex genital capsule which incloses the claspers, internal genitalia, and the anal segment. The dorsal aspect of this capsule has good specific characters in all the species examined. The writer made drawings of the ventral aspect of this capsule when that aspect had good specific characters, because the insects can then be identified without relaxing them.

The genital capsules of the males in the subfamily Alydinæ (Pl. LXII, Fig. 5) are not closed at the caudal ends as those of the above three subfamilies, but are open so that the claspers are exposed except in the genus *Stachyocnemus*. The genital capsule is further characterized in the species of *Megalotomus* and *Alydus* by the presence of a pair of hooks on the dorsal surface. Dr. H. B. Hungerford has suggested that these be called "surcapsular hooks," and the writer has so designated them. (Pl. LXII, Fig. 5.) These hooks have specific value, not only from their shape and position but also from the teeth on them. The writer has found no reference to these hooks in the literature.

The genital capsules of the males of the subfamily Corizinæ (Pl. LXII, Fig. 4) are open at the caudal ends as in the Alydinæ, but on the whole they have a bulbous shape as do the genital capsules in the Coreinæ, Merocorinæ and Pseudophlœinæ. The chief characteristic of the genital capsule in this subfamily is the fact that it and the eighth segment are drawn back up into the body so that they are not visible from a ventral aspect. This condition holds true in the female as well, and at first glance it is difficult to distinguish the sexes. The shape and form of the genital capsules in this subfamily are constant for the species, and are good specific characters.

The shape, size and form of the claspers are constant in each species, and are specific. They can be readily seen in the subfamilies in which they are concealed by relaxing the specimens and pulling out the genital capsules.

The family is a large one. Lethierry and Severin (1893-1896) list 1,320 species, which are divided into 29 subfamilies, as occurring in the world. Many species have been described since then. Van Duzee in his catalogue lists 125 species, which are divided among 48 genera and five subfamilies (Merocorinæ, Coreinæ, Pseudophlœinæ, Alydinæ and Corizinæ), as occurring in North America north of Mexico. Two of these subfamilies (Alydinæ and Corizinæ) have been raised to family rank by Parshley (1923) and Blatchley (1926). Representatives of all five of the subfamilies, 21 of the genera and 35 of the above species are found in Kansas. Fourteen of these 35 species have not been recorded from Kansas before.

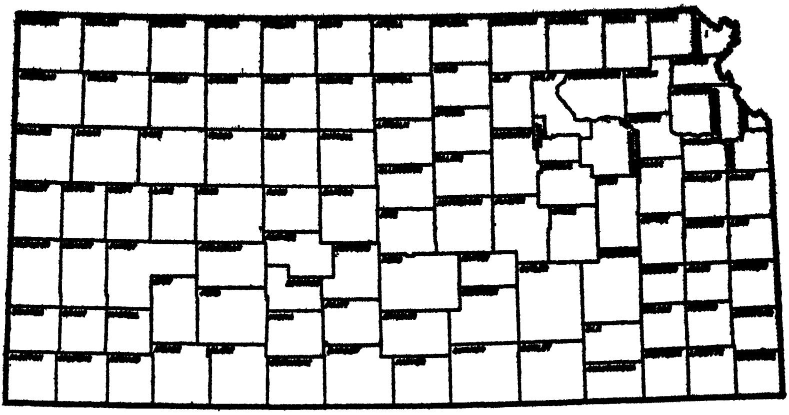

FIG. 1. Outline map of Kansas.

KEY TO THE KANSAS SUBFAMILIES OF COREIDÆ

PAGE

A Head large, the part between the eyes wider than the scutellum; body slender. Alydinæ, 387
AA Head smaller, part between eyes narrower than the scutellum; body rather stout.
  B. Metasternal orifices obsolete .... Corizinæ, 393
  BB Metasternal orifices distinct
    C Hind coxæ contiguous or nearly so, upper surface, except membrane, thickly beset with small granules, each bearing a short seta; first segment of antenna shorter than the head............ Pseudophlœinæ, 386
    CC Hind coxæ widely separated, upper surface not thickly beset with small setæ-bearing granules, first segment of antennæ rarely shorter than the head
      D. Apex of hind tibiæ ending beneath in a short projecting spine, length less than 9 mm .... Merocorinæ, 374
      DD Apex of hind tibiæ without a projecting spine, length 10 mm or more .... Coreinæ, 375

SUBFAMILY MEROCORINÆ (STAL)

This subfamily is represented by a single genus and two species in North America north of Mexico. One of the two species occurs in Kansas.

Merocoris distinctus Dallas.

(Pl LX, Figs 4, 4A)

Dallas, William S List of the Specimens of Hemipterous Insects in the Collection of the British Museum Pt II, p. 419; 1852

ORIGINAL DESCRIPTION (translated by the writer):

"Closely allied to the preceding *Merocoris (M. typhæus* Fabr.); chief difference is that the head is more nearly square, both sides of the front is subspinose; antennæ longer, first and second segments black, third dusky black, punctured, fourth black; posterior tibiæ without curves.

"Female, length, 7/24 inch."

Oblong-oval species of medium size; head small, subquadrangular, porrect, much shorter than the pronotum, armed above near base of each antenna with a pair of short, widely separated, divergent spines; first segment of antenna stout, subcylindrical, constricted near its base, curved, second and third segments more slender, subequal, fourth segment longer than the second and third combined; beak just reaching middle coxæ; eyes prominent, subglobular; pronotum subquadrangular, sides straight, feebly converging forward from the acute hind angles; scutellum short, triangular, its apex acute; apical margin of corium long, oblique, feebly sinuate, the outer angle acute; membrane reaching tip of abdomen, its veins very numerous, mostly simple, connexivum narrowly exposed; hind coxæ extremely widely separated; apex of hind tibæ ending beneath in a short, projecting spine; hind femora curved, strongly clavate, the basal half very slender, the apical half much thickened, and spined beneath.

Length, male, 6½ mm.; width, male, 2 mm. Length, female, 7.5 to 8.5 mm.; width, female, 3⅝ mm.

DISTRIBUTION. It has been collected in the following counties: Douglas, Franklin, Riley, Sedgwick, Rice, Seward, Sheridan, Rawlins, Logan, Cheyenne, Chase and Sherman.

SUBFAMILY COREINÆ (STAL).

This subfamily is represented in the United States by eight tribes. Representatives of five of these eight tribes are found in Kansas.

KEY TO THE KANSAS TRIBES OF COREINÆ.

PAGE

A. Hind femora not greatly enlarged, rarely spinous, in which case the antennal tubercles are moderate in size and separated by a space greater than their own width.
  B. Posterior tibiæ dilated ....Anisoscelini, 376
  BB. Posterior tibiæ not dilated.
    C. Antennal tubercles large and prominent, close together, extending much beyond the apex of clypeus; lateral angles of thorax produced in an acute spine, third antennal segment flattened and expanded. Chariesterini, 382
    CC. Antennal tubercles moderate in size, distant, not extending beyond apex of clypeus, lateral angles of thorax not spined, third antennal segment not flattened and expanded.
      D Second and third antennal segments three-sided; hind tibia three-sided ....Chelinidini, 382
      DD Antennæ cylindrical, tibiæ simple, cylindrical............Coreini, 383
AA. Hind femora spinous or tuberculate, usually much enlarged; antennal tubercles large, separated by a space generally less than their own width.
  B. Clypeus deflexed, not extending much, if any, before antennal tubercles. Mictini, 379
  BB. Clypeus not deflexed, extending much before antennal tubercles. Acanthocephalini, 375

TRIBE ACANTHOCEPHALINI (STAL).

This tribe is represented in North America north of Mexico by one genus. This one occurs in Kansas.

GENUS *Acanthocephala* Laporte.

Five species of this genus occur in North America north of Mexico. One of them occurs in Kansas.

Acanthocephala terminalis (Dallas).

(Pl. LX, Figs. 7, 7A.)

Dallas, William S. List of the Specimens of Hemipterous Insects in the Collection of the British Museum: Pt. II, p. 481; 1852; *Metapodius*.

ORIGINAL DESCRIPTION:

"A blackish-fuscous *Metapodius*, opaque, hairy; antennæ pitch black, last segment golden; tarsi golden, last segment and claws fuscous.

"Length, female, ⅝ inch.

"Above dark brown, opaque, clothed with very short, yellowish hairs, and very thickly and finely punctured. Thorax with the lateral margins smooth, the lateral angles somewhat prominent and obtuse. Scutellum reddish brown. Margins of the abdomen with a small spot at the apex of each segment. Abdomen blackish, somewhat shining, sparingly clothed with short yellow hairs; second and third segments with three small impressed, pale, approximated points on each side of the disc. Breast with a reddish orange spot at each aperature of the odoriferous apparatus; antepectus and the posterior margin of each of the other segments punctured. Legs pitchy, with the four anterior tibiæ brown; thighs serrated beneath; posterior tibiæ not very broad, dilated on the outside to within about one-fourth of their length from the apex, on the inside to about the middle; the margin of the outer dilatation strongly emarginate at the middle; the apical portion of the inner margin of the tibia with a few minute teeth; tarsi reddish orange, with the apical joint and the claws brown. Antennæ pitchy black, with the apical joint bright orange.

"North America. From Mr. Children's collection."

The writer finds the length of the females to be from 22 to 25 mm., and that of the males to be from 18 to 22 mm.

DISTRIBUTION. This species seems to be confined to the eastern and central parts of the state. It has been taken in the following counties: Leavenworth, Douglas, Labette, Cherokee, Montgomery, Wilson, Coffey, Riley, Cowley, Sumner, McPherson, Rooks, Graham, Lyon and Chautauqua.

TRIBE ANISOSCELINI.

Van Duzee lists three genera and sixteen species of this tribe as occurring in North America north of Mexico. Four species of one genus (*Leptoglossus*) occur in Kansas.

GENUS *Leptoglossus* Guerin.

Nine species of this genus have been found in North America north of Mexico. Four of these species have been taken in Kansas.

KEY TO THE KANSAS SPECIES OF *LEPTOGLOSSUS*.

PAGE

A. Clypeus projecting in front of genæ, not deflexed .... *clypealis*, 378

AA. Clypeus deflexed in front of genæ.

  B. Fourth segment of antenna equal to or shorter than the third; outer dilation of hind tibia not scalloped.. *corculus*, 377

  BB. Fourth segment of the antenna longer than the third; outer dilation of the hind tibia scalloped.

    C. Side margins of pronotum behind the humeri unarmed; elytra with a very small oblique pale spot on nervure opposite the base of membrane. *oppositus*, 378

    CC. Side margins of pronotum behind the humeri crenulate or toothed; elytra with a straight white bar opposite the base of membrane.... *phyllopus*, 377

Leptoglossus phyllopus (Linnæus).

(Pl. LX, Figs. 1, 1A.)

Linnæus, Carl. Systema Naturæ, Ed 12: I, pt. 2, p. 731; 1767; *Cimex*

ORIGINAL DESCRIPTION (translated by the writer):

"Thorax immaculate blackish; upper wings with a whitish band; hind-shanks membranaceous and toothed.

"Inhabits America."

Linnæus' brief description is scarcely adequate to distinguish *phyllopus* from the other species of *Leptoglossus*, so the writer has redescribed it from the specimens in the entomological collection at the University of Kansas.

SIZE. Length, female, 18 to 21 mm.; male, 17 to 20 mm.

COLOR. Above chestnut brown, thinly clothed with very fine, short, appressed yellow hairs; three narrow stripes on head, and front margin of pronotum dull yellow; first segment of antenna fuscous, second, third and fourth yellow; elytra with an ivory crossbar opposite base of membrane; under surface reddish-brown, mottled with numerous blackish dots, and thickly pubescent with short silver-white hairs; legs reddish-brown.

STRUCTURAL CHARACTERISTICS. Head three-fourths the length of the pronotum, convex; beak long, reaching to or behind the metacoxæ; antennæ with basal segment stout, as long as head, second and fourth segments subequal, longer than the third. Pronotum with humeral angles prominent, slightly projecting upward, their tips feebly toothed. Hind femora slender, the spines beneath relatively small. Inner dilation of the tibiæ much the narrower, reaching the middle of tibiæ, its margin finely toothed; the outer reaching the apical third, its margin with two wide scallops.

DISTRIBUTION. It has been taken in the following counties: Douglas, Pottawatomie, Riley, Dickinson, Saline, Greenwood, Elk, Chautauqua, Cowley, Sedgwick, McPherson, Reno, Clark and Seward.

Leptoglossus corculus (Say).

Say, Thomas. Descriptions of New Species of Heteropterous Hemiptera of North America; New Harmony, Ind.: p. 12; 1832 Transactions of the New York State Agricultural Society. Vol. XVII, p. 770; 1857 (reprinted by Fitch). The Complete Writings of Thomas Say on the Entomology of North America, Vol. I, p. 326; *Anisoscelis*.

ORIGINAL DESCRIPTION:

"Fuscous; antennæ rufous; posterior tibiæ dilated, not sinous.

"Inhabits Florida.

"Body reddish-brown, rather dark, minutely and densely punctured; head simple, with three rufous lines; antennæ rufous; basal joint much shorter than the second, blackish above, second joint longest; ultimate joint rather shorter than the preceding one, fuscous; thorax with the angles not prominent, rounded; scutel undulated on the disc; tergum on the lateral margin with yellowish lines at the incisures; beneath dull rufous with numerous black points; rostrum extending to the middle of the venter; thighs blackish above towards the tip, spinous beneath, posterior pair a little thickened; tibiæ dull yellowish, posterior pair dilated, not undulated on the edge, fuscous with small yellowish spots; the dilation not continued to the tip; inner edge with a few short spines.

"Length four-fifths of an inch.

"I have obtained two individuals on St. John's river. In one of the two specimens the nervures on the middle of the hemelytra are of a paler color, as if, in some individuals, a pale band might exist in that part."

The writer has but one specimen of this species, an unlabeled female, taken from the student collection at the Kansas Agricultural College. This specimen agrees with the original description very closely, especially with one of the specimens that Say collected on the St. John's river, in that the nervures on the middle of the hemelytra are of a paler color.

Leptoglossus oppositus (Say).

(Pl. LX, Figs. 8, 8A.)

Say, Thomas. Descriptions of New Species of Heteropterous Hemiptera of North America; New Harmony, Ind.: p. 12; 1832. Transactions of the New York State Agricultural Society: Vol. XVII, p. 771; 1857 (reprinted by Fitch). The Complete Writings of Thomas Say on the Entomology of North America: Vol. I, p. 327; *Anisoscelis*.

ORIGINAL DESCRIPTION:

"Reddish-brown; hemelytra with a white point in the middle of the corium; antennæ rufous; head trilineated; posterior tibiæ dilated and sinuated.

"Inhabits Indiana.

"This is very closely allied to *albicinctus* Say, but is uniform in its differential characters. It may be known by the small white points of the hemelytra."

Hind femora relatively slender, their teeth relatively short. Hind tibiæ with dilations broadly oval, reaching but little beyond the middle of the tibiæ, the inner more narrow and bearing a few teeth, the outer with two rather deep scallops. Length: Female, 18 to 20 mm.; male, 17 mm.

DISTRIBUTION. It has been collected in the following counties: Douglas, Riley, Sumner and Cherokee.

Leptoglossus clypealis Heidemann.

(Pl. LX, Figs. 6, 6A.)

Heidemann, Otto. The Proceedings of the Entomological Society of Washington: Vol. XII, p. 195, Pl. 8, Fig 1; 1910.

ORIGINAL DESCRIPTION.

"Body oblong, yellowish-brown, covered with short golden hairs. Head as long as the thorax, narrowing towards the front, the upper part with two parallel black stripes and a short one behind each eye; clypeus not rounded at tip, but conspicuously projecting as a stout spine to nearly the apex of the first antennal joint; rostrum comparatively short, extending to behind the middle coxæ or to the first abdominal segment. Antennæ reddish-brown, about as long as the distance from head to the middle of body; basal joint with a black line exteriorly, equal in length to the third; second and terminal joints subequal. Thorax gradually sloping towards front, finely wrinkled and confluently punctured; lateral margins slightly sinuate anteriorly; the humeral angles bluntly rounded, the edge a little upturned and blackish; the callosities shining black, feebly elevated, separated by a light brown somewhat raised line, continuing faintly backward; the disk of thorax moderately convex, with a few scattered dots; submarginal part of posterior margin depressed, and in front of it a transverse sharp ridge. Scutellum black, the tip yellowish, strongly wrinkled. Hemelytra very finely confluently punctured and with a yellowish-white zigzag band across the corium. Membrane transparent, pale brown, darker at base. Dorsal part of abdomen more or less blackish, the inner sides orange; underside of body pale brown, and dotted black. Legs reddish-brown; hind femora sulcate beneath, armed with a double row of stout black spines; upper side mostly blackish streaked, beset with hardly any tubercles. The membranous expansion of hind tibiæ spatulate-shaped, extending toward apex about two-thirds, being broadest near the point; the inner side of expansion not much narrower than the other side, edged apically with a few spines, finer ones on a single part of the hind leg; the outer expansion feebly sinuated twice, carrying two spines, the surface of the membranous expansion dark brown, wrinkled, and finely golden pubescent, covered with numerous small yellow spots and a larger transparent one on the inner side. Venter with a shallow sulcation.

"Length, 16 to 20 mm.; width across thorax, 4 to 5 mm.

"Type: No. 13229, U. S. National Museum."

This species is distinguished from the other species of *Leptoglossus* known at present by the stout spine projecting conspicuously from the point of the head.

This species has not been reported from Kansas before.

DISTRIBUTION. It has been collected in the following counties: Douglas, Riley, Dickinson, Saline, Rooks, Decatur, Scott, Gray, Meade, Morton and Stanton.

TRIBE MICTINI (STAL).

There are six genera of this tribe in North America north of Mexico. Representatives of three of these are found in Kansas.

KEY TO THE KANSAS GENERA OF MICTINI.

PAGE

A Antenniferous tubercles spined on the outer side, head with a distinct tubercle behind each eye.............................. ....*Euthochtha*, 381

AA. Antenniferous tubercles not spined on the outer side; head not tuberculate behind the eyes.

B. Truncate hind margin of the pronotum not wider than base of scutellum; groove for receiving tip of rostrum behind front legs................*Mozena*, 379

BB. Truncate hind margin of pronotum distinctly wider than base of scutellum; without groove for receiving tip of rostrum...................*Archimerus*, 380

GENUS *Mozena* Amyot and Serville.

This genus is represented in North America north of Mexico by six species. One of these has been taken in Kansas.

Mozena obesa Montandon.

(Pl. LX, Figs. 8, 8A.)

Montandon, A. L. Bulletin de la Societe des Sciences de Bucarest, Roumaine: Vol. VIII, Nos. 1 and 2, p. 8; 1899.

ORIGINAL DESCRIPTION (translated by the writer):

"Rather uniform chestnut brown in color; lateral angles of pronotum obtuse, not prominent; abdomen dilated, much rounded on sides.

"Head without punctures, with some very feeble rugosities, scarcely visible, slightly paler on the sides. Antennæ rather slender, a little longer than the head and pronotum together; the first segment dark brown, a little longer than the median part of head but visibly shorter than the second; the third and fourth subequal, each longer than the first.

"Pronotum with dark punctures easily visible on the disk and posteriorly, the free spaces between the punctures glossy and lightly calloused, paler than the punctures, of the same tint as the anterior part of pronotum. The anterior lateral sides straight, scarcely obtusely sinuated, notched by a series of unequal and irregular black tubercles on their anterior two-thirds, the lateral angle straight or very slightly obtuse, not conspicuous, directed transversely, subrounded, apex not acute.

"Scutellum with rather scattered punctures, the spaces between the points slightly elevated into irregular transverse cushions.

"Elytra clear brown, nearly uniformly colored, a little darker on the apical angles, with scattered dark brown punctures. Each sunken point on the elytra as on the pronotum gives rise to a very small golden hair. Membrane brilliant bronze.

"Top of the abdomen rugose; connexivum fully rounded, dark brown with the base of the segments more or less pale; a small, sharp projection at the posterior angle of each of the segments.

"The tip of the rostrum black; fits into a short groove each side of which is bordered by a small, elevated lamella situated on the anterior part of the metasternum behind the anterior leg.

"Legs brown, rugose, the posterior femora of the males more or less reflexed, with two rows of white tubercles on the underside, and some spiny tubercles, very scattered and irregular, on the upper side; the posterior tibiæ slender and curved, with a strong tooth on the middle of their innerside, much narrowed on their apical half, and spiny on this from the median tooth up to the apex.

"The underside of the body brown, more or less rugose, rather uniform, a little clearer on the chest, a small white band on the sides of the abdomen, narrow, irregular, most accented on the fourth and fifth segments.

"Length, 20 to 21 mm. Width between the lateral angles of pronotum 8 to 9 mm.; at the base of the elytra, 7.5 to 8 mm.; across the abdomen, 7 to 10 mm. Florida. (Two males in my collection, received from W. H Ashmead several years ago under the name of *Archimerus calcarator* F. He did not know their true name.)

"By the form of its pronotum, with the anterior lateral sides nearly straight; the lateral angles a little projecting; the abdomen dilated, noticeably larger than the pronotum, the first segment of the antennæ a little shorter than the second, the insect should not be confused with any of the other species of the genus."

DISTRIBUTION. It has been collected in Rawlins, Barber, Kiowa, Montgomery and Riley counties.

GENUS *Archimerus* Burmeister.

Four species of this genus are listed by Van Duzee as occurring in North America north of Mexico. One of these species has been taken in Kansas.

Archimerus alternatus (Say).

(Pl. LX, Figs. 5, 5A.)

Say, Thomas. Journal of the Academy of Natural Science Philadelphia: IV, p 317; 1825. Complete Writings of Thomas Say on the Entomology of North America: II, p. 243; *Coreus*.

ORIGINAL DESCRIPTION:

"Fuscous; thighs spinous beneath; margin of the abdomen black, with five white lineolar spots; head mutic.

"Inhabits Missouri territory.

"Body deep blackish brown; eyes rufous, a movable black pupil; stemmata sanguineous; antennæ blackish, tip black; thorax punctured, gradually elevated behind, attenuated before, anterior termination as wide as the base of the head, anterior lateral edge slightly dentate, posterior angles rounded; scutel of the male tinged with rufous; thighs, a double series of hardly prominent, robust spines beneath, of which the two opposite terminal ones are much more prominent, distinct and acute: abdomen, margin black, alternating, with five oblique white lines; tergum, disc sanguineous; male, posterior thighs much dilated, very robust, slightly tuberculated above, terminal spines not more prominent than the others, a large prominent spine on the inferior middle; posterior tibiæ dentate towards the tip, refracted in the middle, and with a robust, prominent acute spine on the angle.

"Length of the male, more than four-fifths of an inch; female, nearly three-quarters.

"Somewhat similar to *C. galeatus* Fabr., but is considerably larger, the head is unarmed and in other respects sufficiently distinct. It belongs to the genus *Mictis* of Leach."

DISTRIBUTION. It has been collected in the northeastern part of the state in Doniphan, Atchison, Leavenworth, Douglas, Shawnee and Riley counties.

GENUS *Euthochtha* Mayr.

Van Duzee, in his catalogue of Hemiptera of North America north of Mexico, lists one species of this genus. This one occurs in Kansas.

Euthochtha galeator (Fabricius).

(Pl. LX, Figs. 2, 2A.)

Fabricius, Johann Christian Systema Rhyngotorum Secundum Ordines, Genera, Species, etc.: p. 191; 1803; *Coreus*.

ORIGINAL DESCRIPTION (translated by the writer):

"Thorax serrated fuscous, antennæ pale; posterior femora elevated and toothed.

"Inhabits the Carolinas. Type specimen in the Museum Dom. Bosc.

"Size and form of C. *marginati*. Antennæ pale, last segment fuscous. Head small, acute at both sides of the base of the antennæ. Thorax fuscous, the posterior margin serrated and elevated, feebly spinose. Elytra punctated. The underwings slightly yellow. Legs fuscous, posterior femora thickened, curved, toothed."

SIZE. Length, 15 to 17 mm.; width, 5 to 6.5 mm.

COLOR. Dull yellow or reddish-brown above, thickly marked with fuscous punctures. Antennæ reddish-brown or full yellow, the terminal joint darker. Connexivum reddish-brown, the margins of segments fuscous and marked with yellow, under surface yellow or reddish-brown sprinkled with fuscous dots. Legs the same except the hind tibiæ are paler, immaculate. Pronotum finely and irregularly punctuate. Scutellum finely transversely rugose. Elytra punctate, each puncture having a small yellowish scale.

STRUCTURAL CHARACTERISTICS. Body elongate-oval, depressed above, subconvex beneath. Head short, subquadrangular, broader across the eyes than the apex of pronotum; antenniferous tubercules prominent, extending much beyond the clypeus, which is deflexed, armed on the outside with a small blunt spine. Antennæ slender, the basal segment twice as long as the head, the second and third more slender, the second longer than the third, the fourth stouter, slightly shorter than the third. Rostrum reaches the middle coxæ. Pronotum with front angles produced as a short tooth, basal margin truncate, wider than the scutellum, lateral angles obtuse. Connexivum exposed. Membrane reaches the tip of the abdomen. Femora all armed beneath, the hind ones of male curved and swollen. Tibiæ straight.

DISTRIBUTION. Seems to be confined to the eastern part of the state. It has been found in Leavenworth, Johnson, Douglas, Miami, Linn, Bourbon, Cherokee, Neosho, Osage, Wilson, Chautauqua, Cowley, Riley, Montgomery and Phillips counties. Phillips is in the north central part of the state.

TRIBE CHARIESTERINI (Stal).

This tribe is represented in North America north of Mexico by one genus, *Chariesterus* Laporte. Van Duzee (1917) lists three species of this genus as occurring in North America north of Mexico, but since then Fracker (1919) has described a new species. Of these four species one occurs in Kansas.

Chariesterus antennator (Fabricius).

(Plate LXI, Figs. 4, 4A.)

Fabricius, Johann Christian. Systema Rhyngotorum Secundum Ordines, Genera, Species, etc.: p. 198; 1803; *Coreus.*

ORIGINAL DESCRIPTION (translated by the writer):

"Thorax obscurely serrated, the next to the last segment of the antennæ with a dilated compressed membrane.

"Inhabits the Carolinas. Type specimen in Museum Dom. Bosc.

"Medium sized. Antennæ dark; second segment scabrous, third dilated and membranous, the last claviform. Head, thorax and elytra dark fuscous. Margins of thorax very serrated. Abdomen reddish."

SIZE. Length, 11-14 mm.; width across pronotum, 3-4 mm.

COLOR. Dark brown, with sparse short, appressed brownish-yellow hairs. Dilation of third antennal segment, spines along lateral margins of pronotum, margins of abdomen, beak and tarsi fuscous. Whitish beneath.

STRUCTURAL CHARACTERISTICS. Elongate, slender, depressed above, subconvex beneath. Antennæ with basal segment twice the length of head, third with apical half dilated to form a thin, oval plate, fourth fusiform, shortest. Apex of pronotum but one-third the width of base; front and hind margins of humeral angles toothed, the tip ending in a short, acute spine; posterior margin slightly concave.

DISTRIBUTION. A common species throughout the state. It has been collected in the following counties: Atchison, Leavenworth, Johnson, Miami, Linn, Bourbon, Neosho, Douglas, Riley, Saline, Chautauqua, Cowley, Sumner, Sedgwick, Kingman, Reno, Ellsworth, Rush, Osborne, Phillips, Rooks, Ellis, Kiowa, Clark, Gray, Gove, Decatur, Rawlins, Cheyenne, Wallace, Hamilton, Morton, Lyon, Pratt, Graham and Finney.

TRIBE CHELINIDINI BLATCHLEY.

Blatchley (Heteroptera of Eastern North America, 1926) erected this tribe for the genus *Chelinidea.* There are two species of this genus found in North America north of Mexico. One of them is found in Kansas.

Chelinidea vittiger Uhler.

(Pl. LXI, Figs. 2, 2A.)

Uhler, Phillip Reese. Transactions of the American Entomological Society: Vol. II, p. 366; 1868.

SIZE. Length, 13 to 15 mm.; width across pronotum, 5 to 5.5 mm.

COLOR. Clay yellow, glabrous; head and antennæ brownish-fuscous, head with a broad median yellow stripe; anterior and posterior margins of pronotum, scutellum and membrane fuscous-brown or sometimes darker; elytra dull yellow with dense fuscous punctures, basal half of costal margin and veins yellow; connexivum yellow, immaculate; beneath uniform yellow. The color of the elytra varies considerably. McAtee (1919) has made two subspecies, and each of these subspecies has a color variety.

STRUCTURAL CHARACTERISTICS. Body oblong-oval, depressed above, subconvex beneath, a plump-bodied species. Head subcylindrical, porrect, three-fourths or more the length of pronotum, narrowed and pushed forward in front of bases of antennæ; genæ shorter than clypeus which is strongly deflexed between them; antenniferous tubercles small, widely separated. Antennæ stout, as long as head, pronotum and scutellum combined; basal segment stout, curved half the length of head, second and third segments three-sided, subequal, fourth shortest, fusiform. Pronotum densely punctate, the humeral angles lower than the intervening parts, apex one-half the greatest width. Scutellum transversely wrinkled. Elytra rather closely and evenly punctate. Front and middle femora each with two or three short spines on the inner lower margins near apex, and one or two on the outer. Tibiæ straight, three-sided. McAtee (1919) divided the species into subspecies on the degree of carination of the pronotum and the prominence of the anterior, lateral pronotal tubercles. He keys out the two subspecies as follows:

A. Pronotal margin more elevated anteriorly, with a distinct notch at base of short, rather blunt, and outwardly directed postocular spine........*vittiger* subspecies *vittiger*.

AA. Pronotal margin less elevated anteriorly, sometimes not even carinate (almost evenly rounded); postocular spine reduced to a mere blunt tubercle or even entirely lacking. *vittiger* subspecies *æquoris*.

This species has not been reported from Kansas before.

DISTRIBUTION. It has been taken in Douglas, Franklin, Anderson, Neosho, Wilson, Chautauqua, Greenwood, Chase, Phillips, Rooks, Rush, Clark, Gove, Logan, Wallace, Hamilton, Stanton and Morton counties.

TRIBE COREINI (STAL).

Nine genera of this tribe occur in North America north of Mexico. Two of these genera are represented in Kansas.

KEY TO THE KANSAS GENERA OF COREINI.

PAGE

A. Head very broad, subdepressed; articulation of antennæ cephalic, guarded beneath by an expanded plate of genæ; scent-gland orifices without buttonlike prominence at the anterior margin........*Catorhintha*, 384

AA. Head narrower and more convex; articulation of antennæ laterocephalic, not guarded beneath by an expanded plate of the genæ; scent-gland orifices with a round buttonlike prominence at the anterior margin........*Anasa*, 384

GENUS *Catorhintha* Stal.

Van Duzee lists four species of this genus as occurring in North America north of Mexico. Fracker (1923) described a new species. He also places *Ficana apicalis* Dallas in this genus. Of these six species but one occurs in Kansas.

Catorhintha mendica Stal.

(Pl. LXI, Figs. 6, 6A.)

Stal, Carl. Enumeratio Hemipterorum Vol. I, p. 187; 1870.

ORIGINAL DESCRIPTION (translated by the writer):

"Yellowish-gray, dorsal surface dotted with fuscous; antennæ, rostrum, except apex of first segment, spines of the antenniferous tubercle and the dorsal side of the abdomen, black; ventral margin of connexivum spotted with black, three black spots on sides of pectoris, and a series of six black spots on each side of venter; underside of legs sprinkled with black; apex of third segment and occasionally the apex of fourth segment of the antennæ yellowish-white or pale yellow; two pale yellow spots on dorsal surface of abdomen, yellow spots or bars on connexivum, posterior-lateral margin of thorax and apex of scutellum pale yellow, two small yellow spots on the corium, one median behind the disc, the other faded on the margin of the apex.

"Most like *Catorhintha guttula* (Fabr.), differing only in being larger, under margin black spotted, and underside of legs densely sprinkled with black.

"Countries: Texas, Mexico."

DISTRIBUTION It has been collected in Atchison, Johnson, Miami, Linn, Bourbon, Allen, Franklin, Douglas, Osage, Montgomery, Riley, Chautauqua, Cowley, Rush, Pratt, Barber, Comanche, Kiowa, Ellis, Phillips, Norton, Decatur and Rawlins counties.

GENUS *Anasa* Amyot and Serville.

Seven species of *Anasa* are known from North America north of Mexico. Three of these occur in Kansas.

KEY TO THE SPECIES OF *ANASA*.

PAGE

A. Head armed with a long spine on each side, one-third as long as first antennal segment ....*armigera*, 386

AA. Head not armed with spine.

B Head marked with two black or black-dotted longitudinal lines...... .*tristis*, 384

BB. Head without longitudinal black lines..........................*repetita*, 385

Anasa tristis (De Geer).

(Pl. LXI, Figs. 7, 7A)

De Geer, Carl. Memoires pour servir a L'histoire des Insectes: Vol. III, p. 340, Pl. 34, Fig. 20; 1773; *Cimex*.

ORIGINAL DESCRIPTION (translated by the writer):

"That bug found all over Pennsylvania by M. Acrelius is the size of an oxfly; the body elongated, the abdomen concave on the upperside but very convex on the under side; the antennæ, which are half as long as the body, are four-segmented; the first and last segments are longer than the others. The pronotum is triangular with the lateral angles obtuse.

"The head, the pronotum and the elytra are obscure, brown above, garnished with a great number of glossy black dots; but the membranous portion of the elytra is nearly black and the wings are also black. Beneath the body is gray cinnamon, a little russet, uniformly covered with little concave points. The sides of the prothorax are bordered with gray. The antennæ are brownish-black; the legs brown with black dots; the top of the abdomen is all black. The sober and obscure color of this bug gives it an air of sadness."

This is the squash bug of literature, and as it is the most common, most injurious and the best-known species of the family Coreidæ, that name has been adopted as the common name of the family. It varies a great deal in size. Length, 13 to 18 mm.; width across pronotum, 4.2 to 6 mm.

DISTRIBUTION. It has been collected in Johnson, Miami, Linn, Leavenworth, Douglas, Osage, Riley, Chautauqua, Harvey, Rice, Barton, Decatur, Gove, Gray, Logan, Scott, Finney, Sherman and Morton counties.

Anasa repetita Heidemann.

(Pl. LXI, Figs. 8, 8A.)

Heidemann, Otto. Proceedings of the Entomological Society of Washington (D. C.): VII, p. 11; 1905.

ORIGINAL DESCRIPTION:

"Elongate-oval, uniformly brown or light brown. Upper surface of body, and breast, with irregular rows of dark punctures; from each puncture arises a short, stiff, golden bristle; abdomen transversely wrinkled, the punctures somewhat obsolete, with finer and longer hairs which are more closely placed on the apex of the abdomen. Head without a spine or tubercle near the antennæ; ocelli amber colored, blackish-edged behind; antennæ moderately long and finely pilose; basal joint one-third longer than the head, gradually curved, brown, with a black line exteriorly and a few black dots, the black line even reaching the antenniferous tubercle; second joint a little longer than the first; the third nearly equal in length with the second, both joints about half as thick as the basal joint, black, narrowly yellowish-white at base; terminal joint shorter, fusiform and orange colored. Rostrum reaching the middle coxæ, light brown, black at tip. Thorax broader than long; the disk feebly convex, in the middle a longitudinal narrow, smooth whitish line; lateral margins slightly sinuate anteriorly, and obtusely rounded posteriorly near the humeri; the anterior margin less than half as broad as the posterior; the latter considerably depressed and straight, the transverse raised line above the margin well defined. Scutellum wrinkled; at the basal corners a triangular black spot, and also one at the tip. The disk of the corium has a few dark speckles, formed by the more or less confluent punctures. The membrane brownish and sprinkled with some large black dots, the base darker. The connexivum is edged with white and black lines, and has on the incisures broad, whitish transverse bands. Abdomen much rounded, luteous, on the sides of the segments a few black spots; also, one or two near the base of the coxæ. Feet yellowish-white and dotted with large black spots.

"The genital segment of the male is quite remarkable; it is a little longer than broad, with a transverse, shallow line before the middle, the base convexly rounded and sloping abruptly toward the apex, which is truncate, very feebly indented in the middle, with the corners decidedly humplike in form.

"Length, ♀ 15 mm., ♂ 12 mm.; width across the thorax, ♀ 6 mm., ♂ 5 mm.

"Type, No. 8217, U. S. National Museum."

This is the first record that the species has been taken in Kansas.

DISTRIBUTION. It has been taken in Douglas and Riley counties.

Anasa armigera (Say).

(Pl. LXI, Figs. 5, 5A.)

Say, Thomas. Journal of the Academy of Natural Sciences of Philadelphia: IV, p. 319; 1825. Complete Writings of Thomas Say on the Entomology of North America: II, p. 243; *Coreus.*

ORIGINAL DESCRIPTION:

"Brown, feet white, spotted with black; head spinous above the antennæ; margin of the tergum black, with five white lineloar spots.

"Inhabits Missouri territory.

"Body brown above, beneath pale; eyes prominent rufous; stemmata sanguineous; above the origin of each antenna an elevated, prominent acute spine, half as long as the basal joint of the antenna; antennæ first joint white spotted with black, second and third black, white at base and tip, terminal joint rufous; thorax punctured, elevated behind, descending almost vertically and attenuating to the head; anterior lateral edge dentate, posterior angles dilated and terminated in an angle, from whence the posterior margin descends sinuously and obliquely, terminating in a short acute spine each side of the base; base transversely rectilinear; scutel with three black spots at base; hemelytra, a white oblique line in the middle on the membranaceous portion; tip blackish; feet white, spotted with black; thighs armed at the tip beneath with two short acute spines; tergum sanguineous, base, tip and margin black, the latter with five white oblique lines; venter pale, spotted with black.

"Length of female eleven-twentieths of an inch.

"I have not seen the male of this species; it bears a general resemblance to *C. galeatus* Fabr., and is about equal to that species in magnitude, but it may be at once distinguished by the white transverse line at the base of the membranaceous portion of the hemelytra."

The length of the specimens that the writer has examined varies from 13 to 17 mm.; width across the pronotum, 4.5 to 6.5 mm.

DISTRIBUTION. It has been taken in Douglas, Leavenworth and Riley counties.

SUBFAMILY PSEUDOPHLŒINÆ (STAL).

There are two genera of this subfamily in North America north of Mexico, each of which has two species. One species of one genus occurs in Kansas.

Coriomeris humilis (Uhler).

(Pl. LXII, Figs. 1 1A.)

Uhler, Philip Reese. Notices of the Hemiptera of the Western Territories of the United States, Chiefly from the Surveys of Dr. F. V. Hayden (in F. V. Hayden: Preliminary Report of the United States Geological Survey of Montana and Portions of Adjacent Territories for 1871): p. 403, 1872; *Dasycoris.*

ORIGINAL DESCRIPTION:

"Closely resembling *D. pilicornis,* Burm., of Europe, but rather more slender; the head longer and the antennæ more slender. Fuscocinereous, or pale fulvogriseous, hispid; the head pale beneath; on the sides is a dark brown stripe running from the antennæ to the base, tylus carinately elevated. Antennæ having the second joint distinctly shorter than the third, the fourth pale fuscous, about equal to the third joint in length, antenniferous spines very short, small. Rostrum reaching to the intermediate coxæ; the tip piceous. Pronotum remotely punctured, beset with numerous granular processes, densely clothed with gray pubescence; the lateral margins, with their close-set, short, teethlike processes, whitish; humeral angles with an acute, fuscous tooth, stoùter and not so long as that in *D. pilicornis*. Pectus pale clay yellow, or even whitish, closely, coarsely punctured, granulated, and with whitish, somewhat matted pubescence. Legs pale clay yellow; the femora granulated, pubescent, mottled with brown; tibiæ darker at tip; the tarsi somewhat embrowned, and the nails piceous. Mesosternum blackish. Scutellum coarsely punctured, covered with dense, whitish pubescence; the tip white. Hemelytra best with coarse, brown granules and short, whitish pubescence; the embolium grooved, flecked with brown; membrane pale, the nervures interruptedly brown. Connexivum with pale, transverse lines, between which are fuscous clouds. Venter minutely wrinkled, closely punctured; the pubescence minute, whitish; the basal segments having several brown points each side, and usually with a series on each side of all the segments; the lateral margins interruptedly infuscated.

"The posterior femora usually have two spurs beneath, near the tip, and two or three small teeth close to the tip. Sometimes the two longitudinal nervures of the corium are interruptedly fuscous.

"Length of tip of venter, 8.5 to 9 mm. Width across the humeri, 2 to 2.25 mm."

The writer has seen but two specimens taken in Kansas, a male and female from Gove county.

SUBFAMILY ALYDINÆ (AMYOT AND SERVILLE).

This subfamily is given family rank by Parshley (1923) and Blatchley (1926). Blatchley changes the name of the family to Coriscidæ (Blatchley; W. S. Hemiptera of Eastern North America: p. 256). There are three tribes in this subfamily in North America north of Mexico. Tribe I, Micrelytrini (Stal), has four genera, one of which, *Darmistus,* is represented in Kansas. Tribe II, Leptocorisini, is not represented in Kansas. Tribe III, Alydini, is represented in North America north of Mexico by six genera, four of which (*Megalotomus, Alydus, Tollius* and *Stachyocnemus*) occur in Kansas.

KEY TO THE KANSAS GENERA OF ALYDINÆ.

PAGE
A. Posterior femora not armed with spines.... ... .*Darmistus,* 387
AA Posterior femora armed beneath with a row of spines
B. Scent-gland orifices distinct; antennæ with fourth segment subequal to the second and third segments together.
C. Antennæ with first segment longer than the second ......*Megalotomus,* 388
CC. Antennæ with first segment shorter than the second.. . . . .*Alydus,* 388
BB Scent-gland orifices obscure or obsolete; antennæ with fourth segment much shorter than second and third together.
C. Posterior tibiæ unarmed ....*Tollius,* 392
CC. Posterior tibiæ armed with two rows of strong spines... *Stachyocnemus,* 393

GENUS *Darmistus* Stal.

This genus is represented in North America north of Mexico by one species. This one occurs in Kansas.

Darmistus subvittatus Stal.

(Pl. LXII, Fig. 11.)

Stal, Carl. Oversigt af Kongliga Vetenskaps-Akademiens Forhandlingar: Vol. XVI, p. 469; 1859.

ORIGINAL DESCRIPTION (translated by the writer):

"Pale yellowish-gray, dorsal surface with pectoris distinctly punctated, two fuscous lines on the head and four faint ones on the thorax, the hemelytra distinctly punctated with fuscous; black lines on the ventral surface of head, and a black medioventral line on the pectoris.
"Male, 9 mm. long and 2 mm. wide.
"Texas."

This species has not been reported before as occurring in Kansas.

DISTRIBUTION. It has been taken in Decatur county.

GENUS *Megalotomus* (Say).

This genus is represented in North America north of Mexico by one species. This one occurs in Kansas.

Megalotomus 5-spinosus (Say).

(Pl. LXII, Figs. 10, 10A.)

Say, Thomas. Journal of the Academy of Natural Sciences of Philadelphia: Vol. IV, p. 323; 1824. Complete Writings of Thomas Say on the Entomology of North America: Vol. II, p. 247; *Lygæus*.

ORIGINAL DESCRIPTION:

"Obscure rufous: posterior thighs five-spined; tergum red, margin lineate with black.
"Inhabits the United States.
"Body dull rufous, minutely and densely punctured; head triangular; stemmata sanguineous: antennæ, second and third joints black at their extreme tip, fourth joint dusky, pale at base; rostellum pale, black at tip; setæ black; thorax obsoletely indented longitudinally in the middle and transversely before the middle; posterior angles salient, acute, blackish at tip; scutel pale at tip; feet pale rufous, whitish at base; posterior thighs more robust, rufous at tip, five-spined beneath; pectus, postpectus, and head beneath, black in the middle; tergum red; margin with about four pale spots, and black lineolar edges to its segments.
"Length of body more than half an inch."

Claspers of male forked. The outer lobes the longer.

Length, 14 to 16 mm.; width across the pronotum, 3 to 3.7 mm.

Has not been reported before as occurring in Kansas.

DISTRIBUTION. It has been taken in Johnson, Douglas, Miami, Riley, Chautauqua, Cowley, Harper, Rooks, Graham and Trego counties.

GENUS *Alydus* Fabricius.

Van Duzee (1917) lists six species of the genus as occurring in North America north of Mexico. Fracker (1918) described a new species. Of these seven species five are found in Kansas.

KEY TO THE KANSAS SPECIES OF *ALYDUS* (AFTER FRACKER).

PAGE

A. Pronotum with lateral angles blunt, and sides and lateral margins not distinctly paler than the disc.

  B. Claspers of male with caudomesal margins subparallel, caudal aspect narrow; female of *pluto* with lateral plates of hypopygium terminating in a tumid fingerlike process, sixth ventral segment with a distinct median carina; mainly mountain species.

    C. Antennæ with fourth segment shorter than second and third together, third subequal to second; body black, not densely pilose........*pluto*, 389

    CC. Antennæ with fourth segment more than one-third longer than second and third together, third shorter than second; body variegated with fuscous, densely pilose ....*tomentosus*, 390

  BB. Claspers of male not with caudomesal margins parallel; lateral plates of female hypopygium flat, not tumid at tip, sixth ventral segment with carina short, indistinct or wanting.

    C. Claspers of male twisted, not arcuate; lateral plates of female hypopygium acute at apex; pronotum usually black; membrane infuscate. *eurinus*, 390

    CC. Claspers of male arcuate, divaricate at base and convergent at tip; lateral plates of female hypopygium broadly rounded at apex; pronotum usually with posterior two-thirds fulvous; membrane often spotted. *conspersus*, 391

AA. Pronotum with lateral angles acute and lateral margins pale; claspers of male with lateral expansion and acuminate tip; lateral plates of female hypopygium bluntly rounded, approximate at apex............ ....*pilosulus*, 391

Alydus pluto Uhler.

(Pl. LXII, Figs 12, 12A)

Uhler, Philip Reese. Notice of the Hemiptera of the Western Territories of the United States, Chiefly from the Surveys of Dr. F. V. Hayden (in F. V. Hayden: Preliminary Report of the United States Geological Survey of Montana and Portions of Adjacent Territories for 1871). p. 408; 1872.

ORIGINAL DESCRIPTION:

"Intensely black, much more robust than *A. eurinus* Say. Head more robust, minutely scabrous, pubescent; the constricted portion of the collum shorter; eyes and ocelli prominent; the interorbital surface longitudinally impressed, almost to the line of the antennæ. Sides and underside of the head minutely granulated, punctured, and wrinkled. Antennæ either piceous black, or black, with the bases of the first, second and third joints pale piceous; the underside of base of the first whitish. Rostrum black, reaching to the intermediate coxæ. Pronotum very moderately convex, a little pubescent, coarsely, deeply punctured; the lateral margins slenderly carinated; the carina obsolete at the anterior angles, but considerably elevated on the moderately prominent posterior angles. Callosities broad, large, bald, minutely granulated each side, with two impressed points behind their middle. Propleuræ coarsely, confluently, deeply punctured, except anteriorly, where the punctures are fine; meso- and metapleuræ rather coarsely, irregularly granulated, coarsely punctured behind and below. Legs deep black, pubescent, or with the anterior and intermediate tibiæ pale piceous on the middle; posterior femora with five curved spurs from behind the middle to near the tip; at tip, with two or three close-set, very small teeth; tarsi pale piceous on the base of the first joint. Scutellum coarsely, remotely punctured. Corium less coarsely, rather remotely punctured; embolium smooth, minutely, sparsely, obsoletely punctured, minutely pubescent; membrane brownish-black, with long, close, very numerous nervures. Tergum red as far as the base of the antepenultimate segment, or only a little red on two or three of the basal segments; venter deep black, shining, immaculate, very minutely shagreened, pubescent at tip.

"Length to venter, 12-13 mm.; width across the humeri, 3 mm.

"Inhabits Colorado; Ross Fork, Idaho; Louisiana; and Kansas. The spines of the posterior femora vary in number from three to six; this variation occasionally occurs on the opposite sides of the same specimen. There seem to be about twenty nervures to the membrane, of which two or three are usually forked."

DISTRIBUTION. This species has been collected in Clark, Norton and McPherson counties.

Alydus eurinus (Say).

(Pl. LXII, Figs. 7, 7A.)

Say, Thomas. The Journal of the Academy of Natural Sciences of Philadelphia: Vol. IV, p. 324; 1824. The Complete Writings of Thomas Say on the Entomology of North America: Vol. II, p. 247; *Lygæus*.

ORIGINAL DESCRIPTION:

"Blackish, hairy, punctured; tergum black, disk rufous, margin with four yellowish spots; posterior thighs three-spined.

"Inhabits Missouri and Arkansas.

"Body blackish, hairy, punctured; head triangular; eyes prominent; antennæ, second and third joints dull testaceous, blackish at their tips; thorax densely punctured, mutic; hemelytra black-brown; feet black; tibiæ and first joint of the tarsi, dull testaceous, with black tips; posterior thighs three-spined beneath, and one or two smaller spines at tip; abdomen, reflexed margin with four yellowish spots; tergum rufous on the basal disk.

"Length about half an inch.

"The body of this insect is long and narrow; the diameter of the head which passes through the eyes is but little shorter than the breadth of the thorax."

E. Length, 11 to 15 mm.; width, 2.3 to 3 mm.

COLOR. Color above variable from nearly wholly black to largely fuscous brown; connexivum black, each segment with a small orange-yellow spot near front angle; antennæ fuscous brown, basal segment and tips of second and third segments darker; tibiæ fuscous brown, darker near apex.

STRUCTURAL CHARACTERISTICS. Head finely and densely punctate; antennæ with third segment little shorter than the second, both together but little longer than the fourth. Pronotum with disk convex, but little narrowed in front, deeply and densely punctate, clothed with numerous rather coarse, erect black or brown hairs, as is the head. Scutellum slightly convex, coarsely but not densely punctate. Elytra finely and sparsely punctate. Abdomen slightly dilated at middle, the connexivum rarely narrowly exposed.

This species is easily confused with *Alydus pluto* Uhler if a superficial examination is made, but the genitalia of the two species is very distinct.

DISTRIBUTION. Has been taken in Douglas, Miami and Riley counties.

Alydus tomentosus Fracker.

Fracker, S. B. The Annals of the Entomological Society of America: Vol. XI, No. 3, p. 267; 1918.

ORIGINAL DESCRIPTION:

"Color black, mottled with dark brown; body and legs densely covered with long, fine, black and white setæ intermixed; form more robust than in *eurinus* and not so large as in *pluto*. Head black, marked on each side with a longitudinal flavescent anteocular line, slightly broken at tip of antenniferous tubercle and extending nearly to apex of jugum; also a short, pale fuscous vitta caudoventrad of each eye. (One specimen in addition shows a small fuscous spot behind the ocelli). Antennæ fuscous, first, second and third segments black toward apex; fourth segment more than one-third longer than two preceding together, first shorter than second, subequal to third, and attaining apex of head. Rostrum piceous, paler at incisions, first segment longest, slightly longer than second, and subequal to two apical ones together, fourth one-half longer than third.

"Pronotum densely punctate, black, mottled with fuscous on posterior half of the disk and on the sides, sometimes with an indication of short mediodorsal and lateral marginal fulvous lines near anterior margin. Scutellum black, flavescent at tip. Corium castaneous, mottled with flavescent; membrane infuscate. Thorax and abdomen black beneath, densely hairy, sides of thorax rugose and deeply punctate. Scent-gland orifices well developed. Margins of abdomen minutely flavomaculate. Legs with the coxæ, trochanters and tibiæ castaneous, the latter black at tip; femora black, armed with three or four long spines. Claspers of the male with mesal margins subparallel, caudal surfaces slightly expanded laterally near tip.

"Size male, 10x2.6 mm.

"Holotype: male, from Fort Collins, Colo.

"Paratype: male, from Las Animas, Colo.; both in the Ball collection."

This species has not been reported as occurring in Kansas before.

DISTRIBUTION. It has been taken only in Norton county.

Alydus conspersus Montandon.

Montandon, A. L. Proceedings of the United States National Museum: XVI, p. 49; 1893.

ORIGINAL DESCRIPTION:

"Grayish above, sparsely hairy on the anterior part of the pronotum; head black, anterior margin and a longitudinal spot on the middle of the anterior part of pronotum black, the middle of this black spot sometimes with a very small longitudinal pale line. The posterior part of the pronotum and the elytra grayish with fine punctures, with castaneous and numerous irregular black spots. Membrane pale vitreous with darkish nervures and numerous round spots irregularly scattered on the surface; the greater part of the back of the abdomen red, base and extremity black. Connexivum black with a pale spot at the base of each segment. Body beneath black with metallic bronze reflections, especially on the abdomen. Antenna dark brown, with the basal two-thirds of the second and third joints pale. Legs black, the tibæ brownish, with the base and extremity darkish. First joint of the tarsi brownish, with the extremity black. Length, 10 to 11 mm."

This species is distinguished from *eurinus* by the much sparser and finer punctation of the pronotum, and by the fact that each one of these finer and sparser punctures bears minute appressed yellow hairs.

This species has not before been reported as occurring in Kansas.

DISTRIBUTION: This species has been taken in Rawlins and Riley counties.

Alydus pilosulus Herrich-Schaeffer.

(Pl. LXII, Figs. 5, 5A)

Herrich-Schaeffer, Gottlieb August Wilhelm. Die Wanzenartigen Insection: Vol. VIII, p. 101, Fig. 870; 1848.

ORIGINAL DESCRIPTION (translated by writer):

"An ochre-fuscous *Alydus*, pilose; first to third segments of antennæ, tibiæ and tarsi testaceous, apex fuscous.

"Size and form similar to *A. calcaratus*, but more slender; the brownish ochre-yellow ground color appears as three longitudinal lines on the anterior part of head and as side stripes, and on the anterior black part of prothorax as a median line. Underside of head, metasternum, and the tibiæ near their ends, fresh green.

"Male from North America; from Sturm."

SIZE. Length, 10 to 14 mm.; width across humeri, 2 to 2.7 mm.

COLOR. Color above usually grayish yellow, the head fuscous, with clypeus and a line on each side dull yellow, a narrow stripe below eye and the edge of side margins of pronotum whitish; apical third of pronotum, tips of first three segments of antennæ, tips of tibiæ and tarsi fuscous or black; terminal segment of antennæ dusky; membrane pale brown.

STRUCTURAL CHARACTERISTICS. Elongate, slender, depressed above, subconvex beneath. Pronotum longer than wide, the sides straight and converging, the apex about two-thirds the width of base; humeral angles acute, slightly projecting forward; hind margin subtruncate. Elytra finely and densely punctate.

DISTRIBUTION. It has been taken in Doniphan, Johnson, Douglas, Franklin, Wilson, Chautauqua, Greenwood, Pottawatomie, Riley, Reno, Harper, Pratt, Phillips, Clark, Finney, Scott, Rawlins, Cheyenne and Cowley counties.

GENUS *Tollius* Stal.

Van Duzee in his catalogue lists two species of this genus as occurring in North America north of Mexico. One of these species has been taken in Kansas.

Tollius curtulus (Stal).

Stal, Carl Kongliga Svenska Fregattens Eugenies resa omkring Jorden, Insekter p 234; 1859; *Alydus*

DESCRIPTION (based upon that of Fracker (1918) and Blatchley (1926):

SIZE. Length, 9.5 to 12 mm.; width, 2.2 to 3.5 mm.

COLOR. Head fuscous with a median and two lateral lines reddish-yellow; antennæ pale, the first and fourth segments darker. The pronotum dull yellow sprinkled with fuscous dots and punctures; disk marked with a pair of fuscous, slightly divergent lines. The scutellum fuscous, the tip pale. Elytra with numerous small fuscous blotches; membrane pale, mottled with pale fuscous blotches. Beneath with sides fuscous and middle reddish-brown. Femora mottled, sometimes with yellow rings.

STRUCTURAL CHARACTERISTICS: An elongate-oblong species. Head elongate-triangular, almost as long as the pronotum. First segment of antennæ shorter than the head, second and fourth subequal, third slightly shorter. Pronotum subquadrangular, slightly longer than wide, lateral margins straight, hind margins subtruncate, not toothed. Elytra as wide as the abdomen, the connexivum not exposed; membrane reaching tip of the abdomen. Front and middle coxæ and all tibiæ unarmed; hind femora moderately swollen and with a row of stout spines beneath on the outer margin. The scent-gland orifices obsolete.

This species has not been recorded from Kansas before.

DISTRIBUTION. The writer has seen but one specimen from Kansas, and that one was taken in Wallace county.

Genus *Stachyocnemus* Stal.

One species of this genus occurs in North America north of Mexico. This one is found in Kansas.

Stachyocnemus apicalis (Dallas).

(Pl. LXII, Figs. 6, 6A)

Dallas, William S. List of the Specimens of Hemipterous Insects in the British Museum: Vol. II, p. 479; 1852; *Alydus*

SIZE. Length, 7.5 to 8 mm.; width across humeri, 2 to 2.5 mm.

COLOR. General color yellowish grey or black; pronotum with a large brown or piceous triangle on base, extending forward to the apex by a narrow median line; connexivum piceous, the upper front angle of each segment grayish-yellow; antennæ grayish-brown, the fourth segment darker; under surface and femora varying from pale grayish sprinkled with fuscous dots to piceous.

STRUCTURAL CHARACTERISTICS. Scent-gland orifices obsolete; the shape of the male genital capsule conceals the claspers; head triangular, much narrowed and produced in front of antennæ; antennæ with first segment widened to tip, second and third subequal, slender, fourth longer and thicker than others. Pronotum as wide at base as long, with posterior margin bearing a mesal tooth. Hemelytra reaching to or slightly surpassing the tip of abdomen in length. Anterior and intermediate femora and tibiæ slender and unarmed; posterior femora thickened, attaining apex of abdomen and armed beneath with two rows of acute teeth; posterior tibiæ armed with two rows of strong spines.

This is the first time that this species has been recorded as occurring in Kansas.

DISTRIBUTION. This species has been taken in Clark and Morton counties.

SUBFAMILY CORIZINÆ (MAYR).

This subfamily is represented in North America north of Mexico by three tribes. Representatives of all three of these tribes occur in Kansas.

KEY TO THE TRIBES OF SUBFAMILY CORIZINÆ.

PAGE

A. Anterior angles of prothorax projecting forward in an acute spine.....Harmostini, 393

AA. Anterior angles of prothorax obtuse or rounded

  B. Body over 10 mm. long, hemelytra opaque ....Leptocorini, 399

  BB. Body not over 9 mm. long, hemelytra hyaline..........................Corizini, 395

Tribe Harmostini (Stal).

Van Duzee lists three genera of this tribe as occurring in North America north of Mexico. Two of these genera occur in Kansas.

KEY TO KANSAS GENERA OF HARMOSTINI.

PAGE

A. Abdomen extended laterally beyond the margins of hemelytra, pronotum with a distinct median impression..*Aufeius*, 395

AA. Abdomen not extended laterally beyond the margins of hemelytra; pronotum without a distinct median impression ....*Harmostes*, 394

GENUS *Harmostes* Burmeister.

This genus is represented in North America north of Mexico by six species. Two of them occur in Kansas.

KEY TO KANSAS SPECIES OF *HARMOSTES*.

PAGE

A. Basal segment of antenna scarcely or slightly surpassing apex of head; second and third segments subequal .... *fraterculus*, 394

AA. Basal segment of antenna surpassing the apex of head about one-half its length; second segment shorter than the third ....*reflexulus*, 394

Harmostes reflexulus (Say).

(Pl LXII, Figs 2, 2A)

Say, Thomas Descriptions of new species of Heteropterous Hemiptera of North America; New Harmony, Ind p 10, 1832 Transactions of the New York State Agricultural Society Vol XVII, p 768, 1857 (reprinted by Fitch) The Complete Writings of Thomas Say on the Entomology of North America Vol I, p. 328, *Syromastes*.

ORIGINAL DESCRIPTION:

"Body reddish-brown, with rather large, confluent punctures; head not extending more than half the length of the basal joint of the antennæ, obviously carinate between the antennæ, tubercles each side of the antennæ; acute; antennæ, first joint robust, rough, much narrowed; second joint shorter than the third, terminal joint half as long as the third; thorax, lateral margins a little reflected, the edge concavely arcuated, posterior angles rounded; anterior angles prominent, acute; scutel narrowed before the tip; hemelytra, corium yellowish, rufous near the scutel; nervures very distinct; lateral edges a little reflected; membrane hyaline; beneath, greenish-yellow feet pale rufous; posterior thighs dilated, spinous beneath.

"Length, one-fourth of an inch.

"The rostrum hardly reaches the posterior coxæ. The last joint of the antennæ is elongate-oval and much shorter than the preceding joint, as defined by Latreille in this genus."

Length, 7.5 to 9 mm ; width, 2.2 to 2.7 mm.

DISTRIBUTION. It has been collected in Atchison, Douglas, Bourbon, Osage, Lyon, Riley, Dickinson, Jewell, Ellsworth, Reno, Norton, Hodgeman, Clark, Rawlins, Cheyenne, Greeley, Hamilton, Morton, Stevens and Clark counties.

Harmostes fraterculus (Say).

Say, Thomas Descriptions of new species of Heteropterous Hemiptera of North America, New Harmony, Ind , p 10, 1832 Transactions of the New York State Agricultural Society Vol XVII, p 768, 1857 (reprinted by Fitch) The Complete Writings of Thomas Say on the Entomology of North America Vol I, p 324, *Syromastes*

ORIGINAL DESCRIPTION:

"Anterior point of the head extending nearly to the tip of the first joint of the antennæ

"Inhabits Georgia and Indiana

"Closely resembles the preceding species (*H. reflexulus* Say), but is smaller; the anterior tip of the head extends nearly or quite to the tip of the first joint of the antennæ, the lateral margin of the corium is very distinctly punctured with black; the membrane is marked with a longitudinal obsolete brown line and small points; the general color is darker; the tergum is sanguineous, black at base

"Length, less than one-fourth of an inch

"A small specimen was sent to me by Mr. Oemler, from the vicinity of Savannah, and I have obtained the two sexes in Indiana."

This species has not been reported from Kansas before.

DISTRIBUTION. This species has been taken in Douglas county.

GENUS *Aufeius* Stal.

This genus is represented in North America north of Mexico by one species. This one is found in Kansas.

Aufeius impressicollis Stal.

(Pl LXII, Figs. 8, 8A.)

Stal, Carl. Enumeratio Hemipterorum: Vol. I, p. 222; 1870.

ORIGINAL DESCRIPTION (translated by writer):

"Pale yellowish-gray, sprinkled with fuscous, apical segment of antennæ and disk of mesosternum fuscous or black. Male, female, 5 to 6 mm. long; width of thorax, 1½ to 2 mm.

"Habitat: Mexico, Texas. (Mus. Holm)

"First segment of antennæ sparsely granulated, second and fourth segments equal in length, the third scarcely longer. Head without distinct punctures, sides granulated. Thorax distinctly punctated and sprinkled with fuscous, disk impressed on both sides with short red lines; anterior part depressed; lateral margin sinuate before the middle, minutely crenulated. Scutellum totally punctated. Hemelytra hyaline, membranaceous, veins opaque and elevated, frequently sprinkled with fuscous, exterior veins of the corium granulated on both sides. Membrane transparent, immaculate. The underside occasionally sprinkled with minute fuscous and sides of pectus and venter supplied with densely fuscous sprinkled lines. Pectus distinctly punctated. Apex of abdomen of male narrowly truncate; of the female widely truncate, last ventral segment of the male with apex sinuate, in female produced to apex of abdomen, subrounded medially. Legs variegated fuscous."

DISTRIBUTION. This species has been taken in Douglas, Riley, Kingman, Decatur, Sheridan, Gove, Rawlins, Logan, Kearny and Finney counties.

TRIBE CORIZINI (STAL).

This tribe is represented in North America north of Mexico by one genus (*Corizus* Fallen). This genus is represented by fourteen species, five of which occur in Kansas.

KEY TO THE KANSAS SPECIES OF *CORIZUS*

PAGE

A. Transverse impression of pronotum ending in a loop .... *viridicatus*, 396

AA. Transverse impression of pronotum not ending in a loop.

B. Last segment of the abdomen short and broad, its apex truncate in female, evenly rounded in male .... *hyalinus*, 396

BB. Last segment of the abdomen distinctly longer, its apex acute or rounded in female, obtusely rounded in male.

C. Scutellum broad at tip, rounded .... *indentatus*, 398

CC. Scutellum narrow at the tip and pointed.

D. Connexivum unspotted .... *lateralis*, 398

DD. Connexivum spotted .... *sidæ*, 397

Corizus hyalinus (Fabricius).

(Pl. LXII, Figs. 8, 8A.)

Fabricius, Johann Christian. Entomologia systematica emendata et aucta, secundum classes, ordines, genera, species, adjectis synonymis, locis, observationibus: Vol. IV, p. 168; 1794; *Lygæus*.

ORIGINAL DESCRIPTION (translated by the writer):

"A black Lygæus with margins of the thorax reddish; elytra hyaline with apex fuscous; hyaline punctures.

"Habitat: An island of America. Doctor Pflug.

"Small. Antennæ black. Head black, vertex with reddish punctures. Thorax black, lateral margins reddish. Scutellum black, apex reddish. Elytra hyaline, apex fuscous with large hyaline punctures. Wings white. Body black beneath with red lines. Legs black."

SIZE. Length, 5.5 to 6.4 mm.

COLOR. Above yellow, red, or sometimes very dark, ornamented with darker markings; sternum black; transverse suture of pronotum prominent and black; connexivum not distinctly spotted.

STRUCTURAL CHARACTERISTICS. Posterior lateral angles of metapleura produced into an acute rounded angle; scutellum narrow and acute apically, sides nearly straight; transverse suture of pronotum prominent and black; wings extending much beyond the apex of the abdomen; last segment of the abdomen short, truncate in the female, evenly rounded in the male.

This species is cosmopolitan in distribution, but has not been reported from Kansas before.

DISTRIBUTION. It has been taken in Atchison, Douglas, Miami, Allen, Riley, Sedgwick, Reno and Logan counties.

Corizus viridicatus Uhler.

Uhler, Philip Reese. Notices of the Hemiptera of the Western Territories of the United States, chiefly from the Surveys of Dr. F. V. Hayden (in F. V. Hayden: Preliminary Report of the United States Geological Survey of Montana and Portions of Adjacent Territories for 1871): p. 404; 1872.

ORIGINAL DESCRIPTION:

"Slender, form of *C. truncatus,* Ramb. Pale green; front of the face rather blunt, the end of the tylus decurved; upper surface of the head with whitish, sericeous pubescence, scabrous, uneven, minutely punctured; the underside obsoletely wrinkled, finely pubescent. Antennæ slender, clothed with remote long hairs; the basal joint extending beyond the tylus, freckled with dark brown, and usually with a short stripe on the underside; the apical joint rather slender, hardly longer than the preceding, more or less orange, at base paler; the second and third joints subequal, faintly streaked with brown both above and below. Rostrum reaching not quite to the posterior coxæ; the middle line and the apical joint, excepting at its base, dark piceous. Face and cranium sometimes with a few small spots and streaks of brown or black on the middle and near the eyes. Pronotum with long pubescence, coarsely punctured in irregular, transverse rows, the callosities forming a prominent ridge nearly across the entire width; antepectus and pleura uneven, a little less coarsely punctured; the meso- and metapleura uneven, a little more coarsely punctured; the posterior flap of the metapleura oblique truncated, with the upper angle rounded at tip, and, together with the acetublar caps, minutely punctured. Legs greenish-yellow, the femora rather robust, dotted with brown in rows, those of the upper inward side sometimes confluent in a large patch; tibiæ freckled with brown; at tip and the tips of each of the tarsal joints brownish, the nails piceous. Scutellum uneven, irregularly, somewhat coarsely punctured, the lateral edge recurved, the tips sunken, and its apex almost acute. Corium hyaline, rather finely punctured, the clavus sometimes blackish, or streaked with black; costal and base broadly coriaceous; the nervures usually with a few blackish points and streaks; membrane hyaline. Tergum black on the two or three basal segments, very coarsely punctured at base, and a little less coarsely on the disk; the apex with a black streak running from the penultimate segment to the tip, narrowing posteriorly; the antepenultimate segment often with two or three black dots on the disk; connexivum immaculate, minutely punctured. Venter immaculate, minutely wrinkled and shagreened, finely pubescent. The punctation of the surface is sometimes brownish, either above, or both above and below.

"Length, 5-6 mm.; width across the humeri, 1¾ to 2 mm.

"This species is quite unlike any of the others thus far discovered in the United States, in slenderness and neatness of proportions, as well as the bright freshness of its colors when recent. It inhabits Colorado, Nebraska, and Dakota."

This species is closely related to *Corizus crassicornis* Linnæus.

The writer has found but one specimen that has been collected in Kansas. That one was collected in Rawlins county.

There are no records that this species has been collected in Kansas before.

Corizus sidæ (Fabricius).

(Pl. LXII, Figs. 4, 4A.)

Fabricius, Johann Christian. Entomologia systematica emendata et aucta, secundum classes, ordines, genera, species, adjectis synonymis, locis, observationibus: Vol. IV, p. 169; 1794; *Lygæus*.

ORIGINAL DESCRIPTION (translated by the writer):

"An ash-colored *Lygæus*, sprinkled with fuscous; elytra hyaline, fuscous punctate; antennæ clavate.

"Habitat: South America. Doctor Pflug.

"Small. Antennæ pale, last segment stout, fuscous. Head, thorax, scutellum, body and legs ash-colored, sprinkled with fuscous. Elytra whitish-hyaline with many scattered fuscous punctures. Wings white, immaculate. Abdomen coal black above with an ash-colored band."

SIZE. Length of female, 5.6 to 6.2 mm.; male, 4.4 to 5.5 mm. Width of female, 2.9 to 3.1 mm.; male, 2 to 2.5 mm.

COLOR. The general color varies from dark brown to gray or reddish-yellow, usually rather thickly covered over with very small brown or brightish-red spots; dark line from head extends back on the pronotum, widens and fades out; small black spots cover the body and legs.

STRUCTURAL CHARACTERISTICS. Head narrowly triangular; first segment of antennæ scarcely reaching apex of the head; abdomen short and much wider than the thorax; wings longer than the abdomen.

DISTRIBUTION. It has been collected in Douglas, Wilson, Riley and Decatur counties.

Corizus lateralis (Say).

(Pl. LXII, Figs 9, 9A)

Say, Thomas. Journal of the Academy of Natural Sciences of Philadelphia: IV, p. 320; 1825. Complete Writings of Thomas Say on the Entomology of North America: II, p. 245; *Coreus*

ORIGINAL DESCRIPTION:

"Pale reddish-brown, punctured; hemelytra with spotted nervures; feet, pale, spotted.

"Body somewhat hairy, pale reddish-brown, with much dilated approximate punctures; head somewhat unequal, two obsolete impressed lines between the antennæ, a blackish spot behind the eye; eyes dusky, pale before; antennæ brownish, with sparse hairs; terminal joint as long as the preceding one, dilated, with cinereous pubescence; thorax with three obsolete dusky spots before, and an impunctured whitish line abbreviated before; scutel with a longitudinal, impunctured whitish line; hemelytra, nervures with black spots, interstitial spaces membranaceous; membranaceous tip immaculate, whitish beneath, with a distinct lateral red line; feet hairy, pale; thighs spotted with reddish-brown; pectus rufous; venter yellowish or rufous.

"Length, more than one-fourth inch."

Scutellum constricted near apical third, coarsely not densely punctate, its edges raised and apex subacute. Sixth dorsal segment of female broadly triangular with apex rounded; sixth dorsal segment of male prolonged, subspatulate. Length, 5 to 7.5 mm.; width across humeri, 2 to 3 mm

DISTRIBUTION. Has been collected in Doniphan, Leavenworth, Johnson, Miami, Bourbon, Allen, Douglas, Wilson, Riley, Butler, Sedgwick, Sumner, Kingman, Reno, Norton, Graham, Clark, Lane, Scott, Rawlins, Cheyenne, Morton and Stevens counties.

Corizus indentatus Hambleton.

Hambleton, J. C Annals of the Entomological Society of America Vol I, p 139, 1908.

ORIGINAL DESCRIPTION:

"Somewhat resembling *scutatus*, but smaller and more hairy. Length of female, 4.5 to 6 mm.; width, 2 to 3 mm. Male, length, 4.5 to 5 mm ; width, 2 to 2.5 mm.

"Head: Antenniferous tubercles small but rather sharp, very close to the eyes. Rostral lobes short and obscure. First segment of antennæ reaches a little beyond the apex of the head. Upper surface rough and tubercular.

"Pronotum tubercular, especially in the region of the transverse suture, which is often difficult to trace on this account. This suture forms a rather deep depression on either side of the median line. Scutellum rather broad and rounded at apex; with borders slightly raised near the end, which is not excavated.

"Abdomen but little wider than pronotum. Genitalia pretty much as in *scutatus*, though the entire sixth segment of the female is relatively shorter, and the ventral plate in the male is not so narrow at its middle point. Wings a little longer than abdomen. Whole insect covered with rather dense hair.

"Color, reddish-brown with no distinctive markings. The pronotum is sometimes irregularly blotched with black, and its posterior border with the base of the scutellum, dark or almost black. Beneath the color is lighter, often tinged with yellow and minutely spotted with red. Sternum black, and often a dark brown line on either side of abdomen below, near the borders. The first and second segments of disk of abdomen are black, and the remaining four may be black also, but usually brown. The third has two small spots on the anterior margin and the fourth a rather large oval spot at its center; the fifth has two smaller oblique spots at its anterior margin and several small round spots below these; the sixth with the conventional yellow lateral stripes and the long black spot between them. Connexivum alternating dark and light, sometimes one predominating and at others the other. The dark portions are frequently ornamented with one or more small round spots of a lighter color. The legs are reddish-yellow spotted with brown. Wing veins with a few brown spots. Membrane with a slight reddish tinge."

In so far as the writer can ascertain, but one specimen of this species has been collected in Kansas. That one was taken in Riley county, and is in the entomological collection at the Kansas State Agricultural College.

This is the first time that this species has been recorded as having been collected in Kansas.

TRIBE LEPTOCORINI VAN DUZEE.

Van Duzee lists two genera under this tribe in his catalogue. Representatives of both of these genera are found in Kansas.

KEY TO THE KANSAS GENERA OF LEPTOCORINI.

		PAGE
A.	Bucculæ less than half the length of the head; rostrum scarcely passing hind coxæ .... *Leptocoris*,	399
AA.	Bucculæ reaching the base of the head; rostrum reaching to or beyond the second abdominal segment .... *Jadera*,	400

GENUS *Leptocoris* Hahn.

This genus is represented in North America north of Mexico by one species. This one is found in Kansas.

Leptocoris trivittatus (Say).

(Pl LXI, Figs. 1, 1A.)

Say, Thomas Journal of the Academy of Natural Sciences of Philadelphia: IV, p. 322; 1825 Complete Writings of Thomas Say on the Entomology of North America. II, p. 246; *Lygæus*

ORIGINAL DESCRIPTION:

"Black, thorax trilineate, and hemelytra margined with rufous.

"Body black; eyes and stemmata sanguineous; thorax mutic; two indented transverse lines near the head, of which the anterior one is curved in the middle; three bright rufous lines, of which two are marginal; posterior edge obscurely rufous, hemelytra, coriaceous portion with a rufous exterior and posterior margin, membranaceous tip immaculate; trochanter rufous: tergum rufous with three lateral black punctures; venter, margin and middle rufous.

"Length, nine-twentieth inch."

Length of species examined, 11 to 13.5 mm.; width, 3 to 4 mm.

This is the common box-elder bug. It is more numerous in the autumn. It does considerable damage to the leaves of the box elder (*Acer negundo* L.) and is also said to damage fruit such as peaches, plums and apples.

DISTRIBUTION. It has been taken in Douglas, Riley, Lincoln, Stafford, Rush, Ellis, Meade, Finney, Sheridan, Thomas, Logan, Cheyenne, Sherman and Morton counties.

GENUS *Jadera* Stal.

Van Duzee reports that there are three species of this genera found in North America north of Mexico. Only one (*Jadera hœmatoloma*) of these three is found in Kansas.

Jadera hœmatoloma (Herrich-Schaeffer).

(Pl. LXI, Figs 3, 3A)

Herrich-Schaeffer, Gottlieb August Wilhelm Die Wanzenartigen Insecten · Vol. VIII, p. 103, Fig. 878; 1848; *Leptocoris*.

ORIGINAL DESCRIPTION (translated by the writer):

"A black Leptocoris, with the lateral margins of thorax and all the upper part of the abdomen bright red; eyes and ocelli brown.

"A long, rather pointed oval along each side. The wing covers extended somewhat convexly. The fore margin of thorax thrown up into a broad roll, punctured with large round cells. Dull black; eyes and ocelli rust red; the side margins of the thorax and the entire free margin of the abdomen bright scarlet red.

"This species has the same habitat as the Lygæidæ; the head is distinctly three-parted anteriorly; the fore margin of the thorax is thrown up into a broad roll; the membrane has a vein running across the base and many partly anastomized longitudinal veins. The wing covers extend far beyond the abdomen. Antennæ, head, and the anterior half of the thorax, likewise the legs, are clothed with long bristlelike hairs.

"From Mexico; from Sturm."

DISTRIBUTION. It has been collected in Douglas, Riley, Cloud, Decatur and Sherman counties.

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EXPLANATION OF PLATES.

PLATE LX.

Leptoglossus phyllopus (Linnæus).
FIG. 1. Genital capsule of male, ventral aspect.
FIG. 1A. Left clasper, cephalolateral aspect.

Euthochtha galeator (Fabricius).
FIG. 2. Genital capsule of male, dorsal aspect.
FIG. 2A. Left clasper, median aspect.

Leptoglossus oppositus (Say).
FIG. 3. Genital capsule of male, ventral aspect.
FIG. 3A. Left clasper, caudolateral aspect.

Merocoris distinctus Dallas.
FIG. 4. Genital capsule of male, dorsal aspect.
FIG. 4A. Left clasper, ventral aspect. (Scale 2 × the above.)

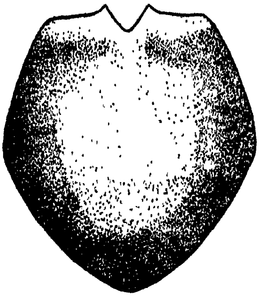
Archimerus alternatus (Say).
FIG. 5. Genital capsule of male, dorsal aspect.
FIG. 5A. Left clasper, caudolateral aspect.

Leptoglossus clypealis Heidemann.
FIG. 6. Genital capsule of male, dorsal aspect.
FIG. 6A. Left clasper, caudolateral aspect.

Acanthocephala terminalis (Dallas).
FIG. 7. Genital capsule of male, dorsal aspect.
FIG. 7A. Left clasper, caudolateral aspect.

Mozena obesa Montandon.
FIG. 8. Genital capsule of male, dorsal aspect.
FIG. 8A. Left clasper, caudolateral aspect.

PLATE LX.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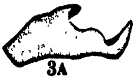
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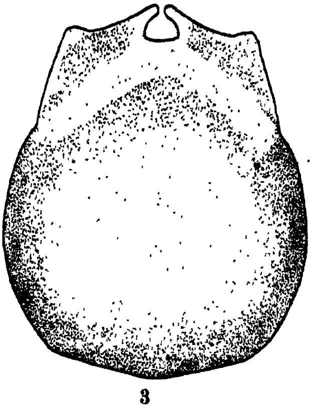
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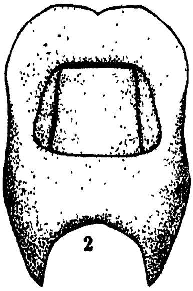
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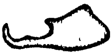
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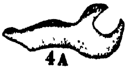
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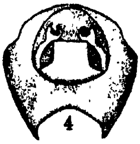
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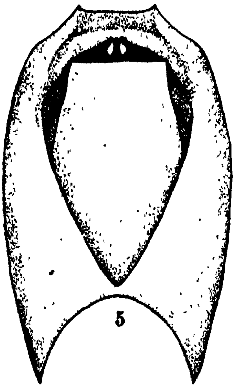
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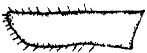
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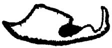
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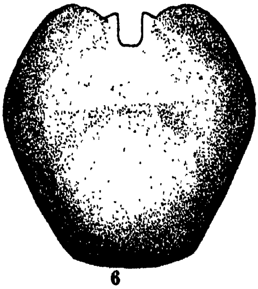
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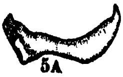
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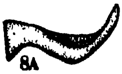
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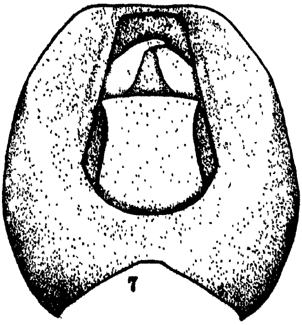
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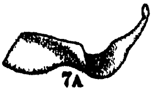
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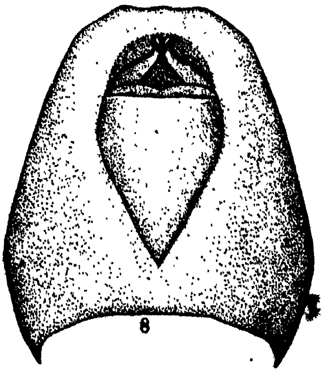
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PLATE LXII.

Coriomeris humilis (Uhler).

FIG. 1. Genital capsule of male, dorsal aspect.

FIG. 1A. Left clasper, dorsal aspect.

Harmostes reflexulus (Say).

FIG. 2. Genital capsule of male, ventral aspect.

FIG. 2A. Left clasper, lateral aspect. (Scale, 2 × above.)

Corizus hyalinus (Fabricius).

FIG. 3. Genital capsule of male, ventral aspect.

FIG. 3A. Left clasper, lateral aspect.

Corizus sidæ (Fabricius).

FIG. 4. Genital capsule of male, ventral aspect.

FIG. 4A. Left clasper, lateral aspect

Alydus pilosulus H.-S.

FIG. 5. Genital capsule of male, dorsal aspect. *cl*, clasper; *sh*, surcapsular hook.

FIG 5A. Left clasper, lateral aspect.

Stachyocnemus apicalis (Dallas).

FIG. 6. Genital capsule of male, dorsal aspect.

FIG. 6A. Left clasper, lateral aspect

Alydus eurinus (Say).

FIG. 7. Genital capsule of male, dorsal aspect.

FIG. 7A. Left clasper, lateral aspect. (Scale, 2 × above.)

Aufeius impressicollis Stal.

FIG 8. Genital capsule of male, ventral aspect.

FIG. 8A. Left clasper, lateral aspect. (Scale, 2 × above.)

Corizus lateralis (Say).

FIG. 9. Genital capsule of male, ventral aspect

FIG. 9A. Left clasper, lateral aspect. (Scale, 2 × above.)

Megalotomus 5-spinosus (Say).

FIG. 10. Genital capsule of male, dorsal aspect.

FIG. 10A. Left clasper, lateral aspect.

Darmistus subvittatus Stal.

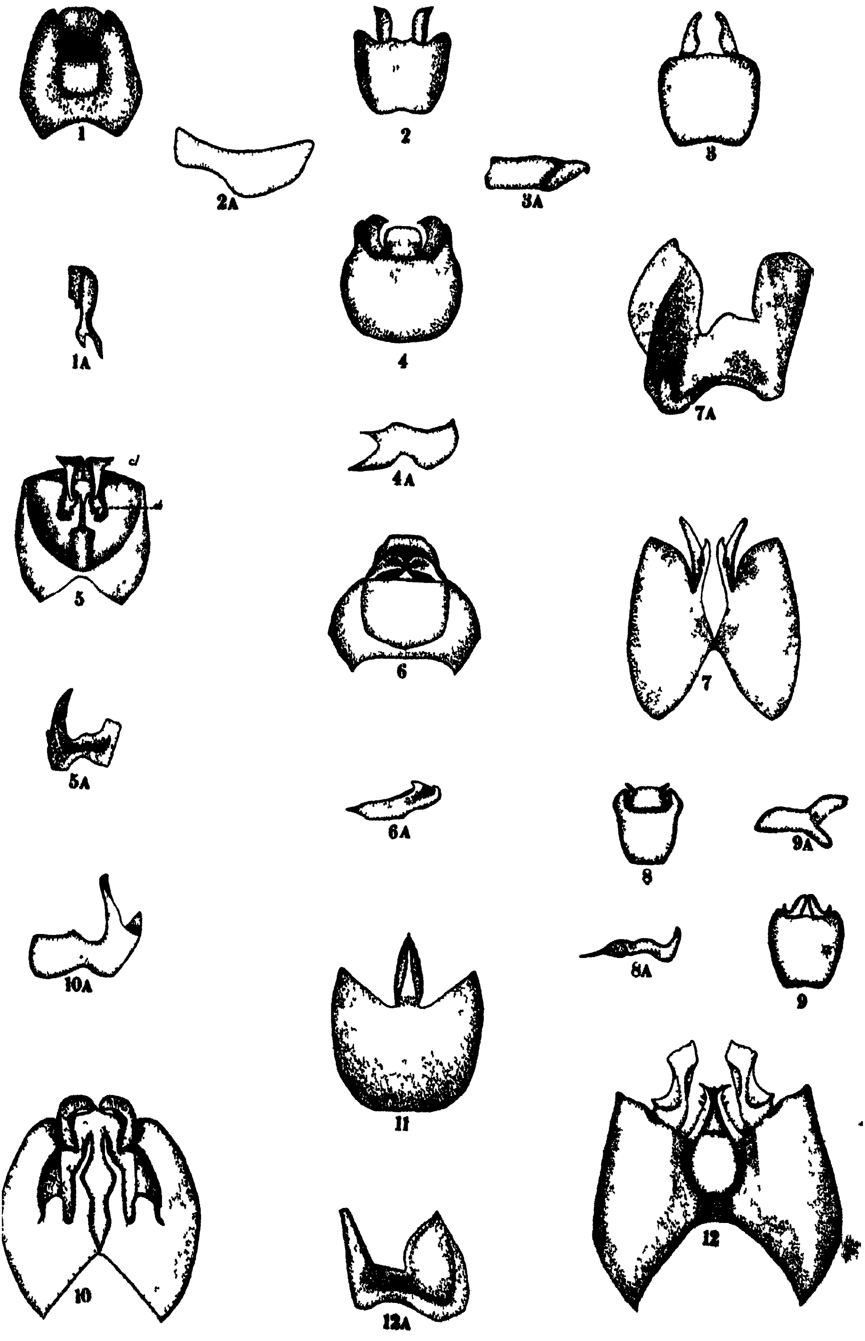
FIG. 11. Genital capsule of male, caudal aspect.

Alydus pluto Uhler.

FIG. 12. Genital capsule of male, dorsal aspect.

FIG. 12A. Left clasper, lateral aspect. (Scale, 2 × above.)

PLATE LXII.



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The Genus *Scolops* (Homoptera, Fulgoridæ).*

E. P. BREAKEY, Department of Entomology.

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INTRODUCTION.

WHILE making a systematic study of the Fulgoridæ indigenous to the Middle West, the writer became aware of the fact that much confusion and uncertainty existed among taxonomic workers as to the species in the genus *Scolops*. In many publications species have been erroneously named and classified. Few writers working with the group have had a clear species concept for the genus, and as a result the mistakes of a predecessor have often been perpetuated. While it is true that several workers have had such a conception, their findings and conclusions have not been published. It was with the aim of untangling the situation and of bringing the genus up-to-date that the following studies were undertaken.

The writer wishes to acknowledge his indebtedness to those who have assisted him in his work: To Dr. P. B. Lawson, at whose suggestions the studies were undertaken and under whose guidance the work was done, he feels the greatest obligation and deepest gratitude; to Dr. H. B. Hungerford, whose sympathetic interest has been a source of continuous inspiration: to Dr. E. D. Ball, who was so generous in the loaning of material, and whose suggestions added much to the progress of the studies; to Mr. W. E. China, of the British Museum, who so graciously extended the assistance he could command; and to each of the following, for the loan of much valuable material: Prof. Herbert Osborn, Prof. C. P. Gillette, Prof. Z. P. Metcalf, Mr. W. J. Gerhard, Dr. S. A. Rohwer, and Dr. T. H. Frison he is very grateful.

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* Submitted to the Department of Entomology and to the graduate faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

DISTRIBUTION.

The genus *Scolops* Schaum, as known at present, is limited to North America. It is best known from the plains region of the temperate zone lying just east of the Rocky Mountains, although its range is now indicated by the following outlying points: Maine on the northeast; Florida on the southeast; Monterey, Mexico, on the south; Nogales, Ariz., on the southwest; California on the west; and Enderby, British Columbia; on the northwest. Uhler's genus *Belonocharis,* which will be treated as a subgenus in this paper, is known only from west of the Rocky Mountains. The range of this group seems to be typically west of and outside of that of the former. Representatives of *Belonocharis* have been examined from Tia Juana, Mexico, on the south; Wenatchee, Wash., on the north; and Rifle, Colo., on the east.

LIFE HISTORY NOTES.

No work seems to have been done toward determining the life histories of the insects in this interesting group. According to the labels on the specimens before the writer, adults occur throughout the summer in this locality from the middle of June to the last of September. Three pairs in copula are before the writer, one pair of *S. hesperius* bearing the date August 8, and two pairs of *S. sulcipes* bearing the date August 10. Females of several species that were known to be carrying ova were selected for dissection, with the hope of finding some suggestions as to oviposition habits. All were dated late in August or early in September. The ova were found to be large and few in number, measuring on the average from 1 mm. to 1.25 mm. in length, and about 0.5 mm. at the greatest diameter. The greatest number of ova taken from any one individual was 12 and the least 5, while the average was around 7. The ova were elongate-oval in shape and quite granulose in appearance. It hardly seems probable that the eggs are inserted in the woody tissues of plants, for the ovipositor of the female is certainly not constructed for such an operation, since the blades are thin and membranous. From this point all is speculation as to how and where the eggs are placed.

COPULATION. Attachment for the copulatory act is made about as follows: The eighth abdominal sternite of the female has become divided along the median line, and from the mesal ends of the halves there projects caudad a pair of appendages, the valves of the ovipositor. These apparently have little to do with the sexual act itself. The posterior margin of each half of this sternite is notched mesad, and it is these narrowed portions that the male grips by placing the hooks of his parameres in the notches on the caudal margins, and bringing the anterior margins of the sternite up against his pygofer hooks. Having done this he is now on his back. The seventh abdominal sternite of the female is provided with a well developed ridge on the anterior margin. The anal plate of the male is bifid on the caudal extremity, and the two halves are turned down forming a pair of hooks. An additional hold on the female is secured by placing these hooks on the anal plate over the ridge on the anterior margin of the seventh abdominal sternite of the female. The ædeagus of the male is then inserted between the valves of the ovipositor. (See Pl. LXIII, Fig. 4.)

HABITAT AND HOSTS

The habitat of the group seems to be restricted typically to moist places near the edge of woodland and to low spots in the prairies that have been undisturbed, and where vegetation has been allowed to make a rank growth. The presence of these insects seems to depend more upon the nature of the vegetation than upon its topographical location, for the writer has had very profitable collecting on hilltops on the prairies, far removed from any such moist situations. *S sulcipes* seems to prefer *Solidago* and *Helianthus,* although it is often found in places where *Ambrosia artemisifolia* is dominant. *S. pungens* has been secured in quantities from nearly pure stands of *Ambrosia artemisifolia.* *S. luridus* was secured from nearly pure stands of *Artemisia,* probably *ludoviciana,* early in September. They are rarely taken in grasslands, and are not to be taken in quantities as are the species of other groups. Since they are collected by the sweeping method it is difficult to say on what particular plants they are living, for the vegetation swept normally consists of a variety of species. It has been found that short, swift strokes of the net, well down into the vegetation, brought the best results, since the insects are shy and very agile in their movements.

SPECIFIC CHARACTERS.

Since confusion has existed among many writers as to what constituted good specific characters, a survey was made of the group to determine what characters were specific and to what extent they were reliable.

VEINS OF TEGMINA. The presence or absence of fuscous markings on the costal cell of the elytra proved to be constant for the species. On these characters it was possible to separate the species of the genus into two nearly equal groups. In some species the veins of the tegmina are concolorous, while in others they are marked in various ways and degrees. Forking of the veins does not offer characters that vary widely enough between the species to be useful.

HEAD AND PROCESS. In a number of species the head is set close up against the pronotum, while in others it is more distant, with somewhat of a constriction behind the eyes. The length of the cephalic process as compared with that of the front, its width as compared with that of the vertex, and its general shape, offer good specific characters. To say that the process is long or short, stout or slender, is ambiguous; but to limit the term "long" to mean as long as the front or longer, and "stout" to mean three-fourths as wide as the vertex or wider, conveys meanings that are tangible. The above terms and others that appear in the descriptions, included as a part of this paper, have been restricted in their meanings, in so far as possible. (See Pl. LXIII, Fig. 1.)

COLOR. Colors and color patterns furnish excellent auxiliary characters. The insect can be considered as having a typical ground color on which are imposed fuscous markings which vary greatly in number, size, density of color, shape of outline, and position on the body, among the species, but are typical within the species. The ground color, together with the fuscous markings, give to the insect a characteristic appearance. It is possible for these fuscous markings to vary greatly in density of coloring, as is shown by the extreme case of *S. pungens*. This is truly, in several respects, a widely varying species, as will be pointed out later. Some species are seemingly devoid of color patterns, while others are richly supplied. The presence or absence of fuscous bands on the fore and middle tibiæ have proven of value as specific characters.

MALE GENITALIA. Studies of the male genitalia of the group revealed specific characters which are practically constant within the species, as shown by the examination of a long series of individuals, in each case where abundant material made such possible, and which will add much to the definiteness of classification. The characters are not at all difficult of access in case one needs to appeal to them in definitely placing an insect systematically. The accompanying drawings are a valuable part of the paper, for there it has been possible to give information many pages of writing would fail to disclose.

SEXUAL VARIATION. The difference in the sizes of the sexes is much more pronounced in some species than in others. The males of *S. grossus* appear to have about half the body bulk of the females, while those of *S. sulcipes* are normally only slightly smaller than the females. In every known case but one the relative body measurements hold regardless of the difference in the sizes of the two sexes. The cephalic process of the male of *S. flavidus* var. *pellos* var. n. is not typical of the species, being proportionally much shorter At first this unusual variation was thought to be due to some accident the insect had had during metamorphosis, but on careful examination the process seems to have had normal development.

DIMORPHISM. Considerable confusion has arisen in the past due to the fact that both macropterous and brachypterous forms occur in the same species, and at the same time. The brachypterous form is by far the more common, and at the present time certain species are known only from that form, while the other form probably exists and will come to light in the future.

WING VENATION.

Metcalf*, in 1913, discussed the wing venation of the Fulgoridæ, from which studies the following summary for the genus *Scolops* will be drawn:

Costa of the fore wing is typically unbranched, usually of somewhat less extent than subcosta. Subcosta lies parallel with radius for its entire length, and both are unbranched. Media is typically two-branched, although these branches may divide again before reaching the apex of the wing. Cubitus is typically two-branched, while the first anal vein is unbranched. The second anal vein is unbranched, while the third anal vein forks once, the inner branch uniting with the second anal vein toward the apex.

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* Metcalf, Z. P. The Wing Venation of the Fulgoridæ. Annals of the Entomological Society of America · VI, No. 3; 1913.

Costa of the hind wing is present only as a weak vein at the base of the wing. Subcosta appears merely as a weak vein lying parallel with the radius along its base. Radius is typically unbranched, although in this group it shows a tendency to branch near the apex of the wing. Media is typically two-branched, as is also cubitus. The first anal vein is unbranched, as is also the second anal vein which lies parallel with it, while the third anal vein is typically three-branched. (See Pl. LXIII, Fig. 2.)

DESCRIPTIONS.

When preparing a monograph of any group it is desirable, when possible, to point out specific characters when describing and redescribing the various species, excluding as many of those characters of a general nature as possible. It is possible to do this by following a uniform plan in writing the descriptions. One must also bear in mind that it is often the combination of specific characters rather than the characters themselves that is important in determining a species. The terminology used is very important, and an effort has been made to be consistent and strict in the use of terms, employing those that have come to be accepted and used by the authorities working in related fields.

MEASUREMENTS. Body measurements have been employed only as gross indicators. The length of the body has been restricted to mean the distance from the sulcus to the tip of the telson. The term "sulcus" as here used refers to the transverse groove that separates the front from the cephalic process. Wing lengths have not been used since they were found to be too variable. Body width has been restricted to mean the greatest width across the body just caudad of the tegulæ. The length of the front means its greatest length, which includes the latero-posterior angles. Comparative measurements have proven much more reliable and therefore are much to be preferred to actual measurements. Such have been used whenever they were found to offer specific characters.

COLOR. To describe a color or color combination has presented one of the most difficult phases of the present studies. In describing the color charateristics of each species the writer has striven for consistency and accuracy, knowing full well that what may be interpreted by one reader in one way may receive a different interpretation from another. Whenever possible the coloring of recently collected material has been made the basis of the description.

TECHNIQUE FOR PREPARING SPECIMENS.

The most satisfactory method for preparing material for study is about as follows: After the labels have been removed from the mounted specimens, it is placed, pin and all, in boiling water and allowed to remain for a few minutes only. Care should be taken to have the heat so regulated that the water is not bubbling. If the specimen is mounted on a paper point it will come loose; and if not, it will be easy to remove the pin from the relaxed insect without causing damage. The labels should be placed on a pin, together with a number corresponding to that on a bottle to which the relaxed specimen is transferred, and preserved for future use and reference. A quantity of a solution of ten per cent alcohol is placed in the bottle containing the relaxed specimen. After the specimen has remained in this solution over night it is sufficiently relaxed for study.

To mount the specimen for study it is necessary to pin it down on a paraffin dish in such a way that a true lateral view of the genitalia may be obtained. A suitable paraffin dish may be prepared by filling the lid of a small tin box with paraffin, and as the paraffin cools making a depression in it by pressing with the thumb. The specimen is pinned on its left side near the margin of this depression by first inserting a pin in the groove between the middle and hind coxæ; second, by lifting the wings on the right side and inserting a pin under them on a slant, so that it holds the wings from over the genitalia and prevents the specimen from sliding up on the first pin; and third, by placing a pin on either side of the head in such a way that the specimen is made rigid. The specimen need not suffer the least injury, since it is not necessary to pierce the body wall or appendages. With the specimen fixed in this position it is ready for examination under the binocular. Enough water should now be placed in the depression to completely cover the specimen so that a clear, undistorted view is obtained. The genitalia can be opened by pulling the anal plate and parameres away with a dissecting needle.

As soon as the necessary studies have been made the specimen should be returned to its vial, and absolute alcohol added in place of the former solution, for desiccation. After remaining in the absolute alcohol for twenty-four hours, xylol should be substituted, and it allowed to stand for another twenty-four hours. From the xylol it can be remounted as before and the proper labels returned. By following such a procedure the specimen is damaged very little, if any. Greenish colorings will be destroyed, but the fuscous colorings and markings will be practically unchanged. Some bleaching will result from the absolute alcohol, but this is much to be preferred to removing the genitalia from the specimen. The genitalia of holotype specimens have been studied by the above method, when one would hesitate to undertake such studies if to do so it were necessary to remove the genitalia, with the subsequent damage to the specimen.

MALE GENITALIA.

The male genitalia of the genus fall typically into three groups. For the sake of comparison and reference these will be designated as the *sulcipes* group, the *grossus* group, and the *Belonocharis* group. In structure they are typical of the Dictyophorinæ, and consist primarily of a median tubular organ, the ædeagus, and a pair of lateral appendages, the parameres. The nomenclature adopted is essentially that accepted and used by the authorities of to-day.

ÆDEAGUS. This organ in *Scolops* seems to consist of a pair of appendages, subsequently united dorsally and ventrally, in the form of a tube. Such a development is not so evident in *Belonocharis*. In *Scolops* the distal ends of these appendages have bladelike structures that are stiffened with chitin. These have been termed the ventral blades, and show characters of structure that are constant for the species, which should aid materially in classification and in arranging the species phylogenetically. Dorsad of the ventral blades and between them project the conjunctiva appendages. These appendages are present and well developed in *Beloncharis,* while the ventral blades are entirely wanting. In the *sulcipes* group the conjunctiva appendages are short and do not extend beyond the ventral blades, but in the other groups they are longer and have a characteristic appearance for each. Those of *Belonocharis* are well developed and stand almost at right angles to the longitudinal axis of the ædeagus The identity of the *grossus* group is readily established by the appearance of these appendages, which are slender, long, and bent dorso-cephalad until they point in almost the same direction as the longitudinal axis of the ædeagus. The shape of the unchitinized part of the ædeagus depends much on the relaxing, and cannot be relied upon for specific characters.

PYGOFER HOOKS. It will be noted that the latero-posterior angles of the pygofer in *Scolops* have been drawn out and folded laterally, so that a stout, heavily chitinized hook has been formed. *Belonocharis* does not have such a hook, for while the latero-posterior angles have been drawn out, no lateral bending has taken place. These hooks, in general appearance and relative position with respect to the pygofer, offer auxiliary characters that are of value in placing a species systematically.

PARAMERES. These are a pair of appendages that lie on either side of the ædeagus, inclosing it laterally and ventrally when it is not in use. The lateral hooks on these appendages are not set so far caudad in *Belonocharis* as in *Scolops*. The parameres offer characters in shape and appearance that are constant for the species.

ANAL PLATE. The tenth (X) abdominal segment constitutes a flattened, bilobed organ which has been designated as the anal plate. Attached to the eleventh (XI) segment is the telson (anal style) The anal plate is more or less bifid dorsad, folded somewhat ventrally, forming a dorsal covering over the ædeagus and parameres when the genitalia are not in use. This organ offers characters in outline that are of specific value, but fails to show group differences. (See Pl. LXIII, Fig. 5.)

SPECIES IN SYNONYMY.

With a large series of specimens available for examination, representing *S. spurcus* Uhler and *S. desiccatus* Uhler, it became increasingly difficult to determine the dividing line between the two. Numerous specimens were studied from north, south, east and west; and one extreme, represented by *S. spurcus*, gradually graded over into the other, represented by *S. desiccatus*, when external characters were used. An examination of the male genitalia of a long series of specimens taken from both extremes disclosed no essential specific differences. It appeared that Uhler had described as two distinct species the extremes of a widely distributed species as represented by a brachypterous form from Texas and a macropterous form from Maryland.

To carry the studies to their final conclusion, the types were secured from the National Museum. Uhler had made females holotypes; but along with these came males from the same localities as the types and of the same form, bearing determination labels in the same handwriting as that on the type labels. These male specimens were prepared for study, and lateral views of the opened genitalia were drawn. When these drawings were compared they proved to be nearly identical. With the genitalia as a working base the species was studied in greater detail, and the following conclusions were reached: The species is a widely varying one, both as regards body size and color density. The color pattern remains essentially the same as do the proportionate body measurements. The apparent size of the insect varies much, due partly to the appearance of a number of macropterous individuals and undersized brachypterous males. Certain specimens appear almost black, while others have a yellowish-grey appearance. A careful examination shows the difference to be almost wholly a matter of color density, the pattern remaining essentially the same. *Scolops desiccatus* then is a synonym of *S. spurcus.*

About the time these studies were finished Mr. Z. P. Metcalf forwarded for study the holotype of his *S. parvulus.* When examined the genitalia of this specimen proved to be almost identical in every detail with those of *S. spurcus* Uhler and *S. desiccatus* Uhler. Since this specimen was a small brachypterous male, its actual body measurements would not agree with those given by Uhler for *spurcus,* but the color pattern was essentially the same as were the comparative body measurements. When compared with the types of *S. spurcus* and *S. desiccatus,* outside of being smaller in size, it displayed no essential specific differences. It, too, is a synonym of *S. spurcus* Uhler.

S. spurcus Uhler must be a synonym of Germar's *pungens.* The following arguments will be cited in support of the above conclusion: In describing *pungens* Germar gives its size as half that of *Dictyophora pannonica* Crucz. Specimens of *D. pannonica* were measured, and it was found that the body length was about 12 mm., which would give *S. pungens* a body length of 6 mm., and Uhler gives 5.5 to 6 mm. as the body length of *S. spurcus.* Germar states that *S. pungens* has "a slender, upturned stylus a little longer than half the length of the body, with the apex truncated." Such a description would fit the frontal process of Uhler's *spurcus* very well, and does not contradict his description in the least. The description of the thorax of *S. pungens,* while not so detailed, is essentially that of *S. spurcus.* Yellowish is given as the ground color of *S. pungens,* which would more nearly fit *S. desiccatus* than *S. spurcus.* In describing the elytra of *S. pungens,* Germar states that they are "yellowish, with white and black points, the apical margin variegated with fuscous." Such a description would fit the elytra of either *S. spurcus* or *S. desiccatus.*

Kentucky was given as the type locality of *S. pungens,* and of the species known to occur there, the description of the process rules out all but *S. sulcipes* Say and *S. spurcus* Uhler. Since the apical margins of the elytra of *S. sulcipes* cannot be considered as being variegated with fuscous, and the tip of the process cannot be considered truncated, in the sense that it is in *S. spurcus*, Germar certainly did not have *S. sulcipes* before him when he wrote his description.

Fowler's *cockerelli* is another species about which much uncertainty has existed. The original description means little or nothing. Fowler states that his description was based on a single female specimen collected on the northern frontier of Mexico, but Mr. W. E. China, of the British Museum, finds that this specimen is a male. Specimens of the following species, which seemed to be close to *S. cockerelli*, namely, *S. maculosus* Ball, *S. perdix* Uhler, *S. uhleri* Ball, *S. robustus* Ball, *S. snowi* sp. n., and *S. austrinus* sp. n., were sent to Mr. China for comparison with the type. Mr. China very graciously made the comparisons requested, and in discussing his findings wrote: "*S. cockerelli* comes nearest to *robustus*, but the insect is broader across the base of the tegmina, and the cephalic process is longer and thicker than in *robustus*." He also went to the trouble to prepare many drawings to illustrate the difference that existed between the type of *S. cockerelli* and the species sent for comparison.

Dr. F. H. Snow, while on one of his trips into the Southwest, collected many specimens of the insects in this and allied groups, among them two species of *Scolops* new to science and a good series of *S. robustus*, all of which were secured in Southern Arizona. An examination of the specimens of *S. robustus* revealed that they varied somewhat in size, and that the process became proportionately longer and stouter as the size increased. It was found that a somewhat similar variation occurred among the cotypes, but a careful study of the genitalia of specimens from the extremes removed any doubt about their not being the same species.

A male specimen of this species, that seemed to represent the extreme in its large size, was found in the entomological collections of the Kansas State Agricultural College, bearing a simple label marked "Tex." This specimen was compared with the cotypes of *S. robustus* Ball, and although it presented no essential specific differences, it was thought that it might represent Fowler's *cockerelli*. The genitalia were found to be identical with those of a cotype specimen of *robustus*. A drawing of the lateral view of the genitalia was prepared and sent, together with the specimen, to Mr. China, of the British Museum. Mr. China was kind enough to relax the type of *cockerelli* and to prepare a drawing of its genitalia from the same view. The drawings are doubtless of the same species. The few differences that exist are due to the fact that the type of *S. cockerelli* was not subjected to the same treatment in preparation for study as had been used with the specimen from Texas. Mr. China very carefully compared the two specimens and summarized his findings. The differences that he found are immaterial, for the most part, since the present studies have shown that such can be expected to be found within the species. The following statements taken from his letter are important and worthy of record: "Genitalia very similar to those of *S. cockerelli*, but there are slight differences in the parameres. . . . In coloring the two specimens are almost identical." *S. cockerelli* then is a synonym of *S. robustus*.

Scolops fumidus (Uhler) exists in both the macropterous and brachypterous forms. The brachypterous form is small and distinctly oval in appearance, while the macropterous form is larger, with very long and widely flaring wings. It is evident from Uhler's description that he had only brachypterous males before him while writing. Van Duzee's *piceus* must be a macropterous female of Uhler's *fumidus*. There is so much difference in the size that the mistake was natural. Both brachypterous and macropterous specimens are before the writer. That both are the same species there is no doubt. The macropterous female fits Van Duzee's description, and the brachyterous male fits Uhler's description, and both will fit either description very well. *S. piceus* Van Duzee then is a synonym of *S. fumidus* (Uhler).

As a result of these studies the following species new to science have been added to the genus: *S. pruinosus* sp. n., *S snowi* sp n., *S. austrinus* sp. n., *S. luridus* sp. n., *S. immanis* sp. n., *S flavidus* sp. n., *S. stonei* sp. n., and *S. flavidus* var. *pellos* var. n.

These studies have also established the following synonymy: *S. parvulus* Metcalf = *S. desiccatus* Uhler = *S. spurcus* Uhler = *S. pungens* Germar; *S. cockerelli* Fowler = *S. robustus* Ball; and *S. piceus* Van Duzee = *S. fumidus* Uhler.

KEY TO THE SUBGENERA OF THE GENUS *SCOLOPS*

PAGE

A Fore and middle tibiæ not foliaceous, not broader than those of hind legs Vertex and pronotum in same plane Eyes approximating pronotum *Scolops* Schaum, 429

AA Fore and middle tibiæ foliaceous Vertex above plane of pronotum Eyes distant from pronotum *Belonocharis* Uhler, 448

SYSTEMATIC TREATMENT OF THE SUBGENUS *SCOLOPS.*

KEY TO THE GENUS *SCOLOPS.*

NOTE.—*Cephalic process long;* as long as front or longer. *Cephalic process stout;* three-fourths as wide as vertex or wider when measured at sulcus.

PAGE

- A. Costa and costal cell of elytra with fuscous markings.
  - B. Veins of corium concolorous.
    - C. Elytra with numerous cross-veins apically.
      - D. Longitudinal veins margined with narrow, dark bands; cross-veins strong, numerous; cephalic process slender.........*S. sulcipes* Say, 443
      - DD. Longitudinal veins margined with fuscous dots in pairs; cross-veins weak, less numerous; cephalic process stout, *S. osborni* Ball, 442
    - CC. Elytra without numerous cross-veins apically.
      - E. Cephalic process slender, less than half as wide as vertex when measured at sulcus; fore and middle tibiæ twice banded with blackish-fuscous..................*S. austrinus* sp. n., 437
      - EE. Cephalic process stout, three-fourths as wide as vertex when measured at sulcus; fore and middle tibiæ not banded with fuscous . ...*S. vanduzei* Ball, 439
  - BB. Veins of corium not concolorous.
    - F. Cephalic process long; form not robust.
      - G. Cephalic process about one-half as wide as vertex, sides parallel; form elongate-oval; color brownish ....*S. perdix* Uhler, 431
      - GG. Cephalic process about three-fourths as wide as vertex, sides divergingly curved posteriorly; form broadly oval; color greyish-testaceous to blackish. *S. pungens* Germar, 438
    - FF. Cephalic process short; form robust.
      - H. Median carina of front ending at sulcus; process not rugose, not inflated anteriorly.
        - I. Cephalic process stout, as broad as vertex when measured at sulcus, curved upward, sides converging anteriorly; color yellowish......*S. hesperius* Uhler, 439
        - II. Cephalic process slender, less than three-fourths as wide as vertex when measured at sulcus, straight sides, nearly parallel; color fuscous. *S robustus* Ball, 434
      - HH. Median carina of front continuing on process to tip; process rugose, inflated anteriorly.
        - J. Veins of elytra prominently marked with blackish-fuscous; color, a rich brown ....*S grossus* Uhler., 445
        - JJ. Veins of elytra nearly concolorous, sometimes faintly marked with small whitish points; color, pale brownish to straw yellowish. *S. immanis* sp. n., 447
- AA. Costa and costal cell broadly whitish, unmarked.
  - B. Veins of elytra concolorous
    - C. Cephalic process long and stout, as wide as vertex when measured at sulcus.
      - D. Process inflated anteriorly; longitudinal veins of elytra margined with faint fuscous bands......................*S. luridus* sp. n., 440
      - DD. Sides of process converging anteriorly; longitudinal veins of elytra not margined with fuscous bands...........*S. flavidus* sp. n., 441

PAGE

CC. Cephalic process short and stout, not as wide as vertex when measured at sulcus.

E. Elytra covered with a silvery pruinosity; color light straw-yellow, faintly marked with fuscous.......*S. pruinosus* sp. n., 435

EE. Elytra, a dark reddish-brown; body pale yellowish, unmarked; process of male very short and stout, that of female as in typical *S. flavidus*.......*S. flavidus* var. *pellos* var. n., 442

BB. Veins of elytra not concolorous.

F. Cephalic process long.

G. Process slender, about two-thirds as wide as vertex when measured at sulcus, sides strictly parallel.

H. Costa, the forks of cubitus, and the first anal vein broadly white, unmarked; form robust ....*S. uhleri* Ball, 444

HH. Excepting costa, all veins of elytra marked alike with brownish-fuscous throughout; elongate-oval ....*S. stonei* sp. n., 432

GG. Process stout, three-fourths as wide as vertex when measured at sulcus, sides not parallel.

I. Process parallel-margined, often slightly inflated at tip, elytra maculate with blackish-fuscous and white. *S. maculosus* Ball, 446

II. Process tapering anteriorly, elytra reddish brown ....*S. snowi* sp. n., 433

FF. Cephalic process short.

J. Color, light green; veins of elytra darker, alternately interrupted with whitish; costa paler, greenish. *S. viridis* Ball, 436

JJ. Color dark reddish-fuscous; veins of elytra irregularly marked with fuscous; costa conspicuously broadly white, *S angustatus* Uhler, 430

Scolops angustatus Uhler.

(Pl. LXIII, Figs. 6, 6a.)

Uhler. Bul. U. S. Geol. Geog. Surv.: I, p. 850; 1876.

Cephalic process very short, very slender; form elongate-oval; color a dark, rich, reddish brown; costa broadly white, unmarked.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process short and slender, straight, shorter than front in ratio of seven to ten, narrower than vertex in ratio of one to three, sides parallel; tip truncate, polished. Vertex broad, somewhat convex, polished; caudal margin somewhat carinate at extremities, median carina obsolete; lateral margins prominently carinate, convergingly curved till over sulcus, then continuing on process parallel to tip. Margins of front straight, converging anteriorly, abruptly constricted to sulcus, then continuing on process parallel to tip; three carinæ of front equally prominent, median carina ending at sulcus. Lateral margins of pronotum carinate, straight; submarginal carinæ becoming obsolete anteriorly; caudal margin very broadly arcuated anteriorly, incised at center; central disc broader than long in ratio of four to three; lateral margins carinate, very broadly arcuated laterally, convergingly curved anteriorly; median carina prominent. Scutellum broader than long in ratio of nine to seven; lateral margins of central disc carinate, median carina faintly indicated. Cubitus and media forking unequally, both well removed apically from junction of second and third anal veins, median further back.

COLOR CHARACTERISTICS. Beneath, orange yellow, more or less uniformly infuscated; above, a rich, reddish brown. Vertex shining, a pair of blackish-fuscous spots anteriorly. Front and ventral compartments of process pale yellowish, lateral compartments of front irrorate with fuscous. Process dark brown laterally and dorsally, latero-dorsal carinæ lightly yellowish. Pronotum lightly guttate with fuscous; a transverse series of six blackish-fuscous spots broadly arcuated anteriorly. A piceous-black spot between ventral extremity of postocular process and eye, none behind antenna, but another ventrad of center of epipleura. Scutellum guttate with fuscous, a pair of blackish indented points near apex of disc. Tegulæ clouded with fuscous. Elytra usually a rich brown; veins lighter, interrupted with fuscous; costa broadly white, unmarked; a light area along the proximal branches of cubitus and media apically, radial cell darker.

LENGTH. From sulcus to tip of telson, male and female 6 mm.; process, 1 to 1.3 mm.; greatest width, 2.6 to 3 mm.

Specimens are before the writer from many parts of the United States.

LOCALITY RECORDS. *British Columbia,* Colorado, Connecticut, Dakotas, District of Columbia, Florida, Georgia, Iowa, Indiana, *Kansas,* Louisiana, Maryland, Massachusetts, Minnesota, *Montana,* Nebraska, New Jersey, New York, Ohio, *Oregon.* The names in italics are additional to those listed by Van Duzee.*

Scolops perdix Uhler.

(Pl. LXIII, Figs. 7, 7a.)

Uhler. Trans. Md. Acad. Sci.: I, p. 405; 1900.

Cephalic process long, very slender, straight; form elongate, elytra narrow, nearly parallel-sided; general color dark greyish-testaceous.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process long and slender, as long as front, a little less than half as wide as vertex when measure at sulcus, parallel-margined. Vertex convex, shining; median carina wanting; caudal margin faintly carinate, straight; lateral margins carinate, prominent, straight, nearly parallel, abruptly converging till over sulcus, then continuing on process parallel to tip. Lateral margins of front carinate, straight, nearly parallel, abruptly constricted to sulcus and continuing on process parallel to tip; five carinæ of front equally prominent, three middle carinæ becoming obsolete before sulcus. Lateral margins of pronotum carinate, straight; submarginal carinæ becoming obsolete anteriorly; caudal margin narrowly arcuated anteriorly, incised at center; central disc as broad as long; lateral margins carinate, nearly parallel, sinuate mesad near centers, convergingly rounded anteriorly; median carina present, acute. Scutellum broader than long in ratio of four to five, margins of central disc carinate, median carina indicated. Cubitus and media branching unequally, cubitus near junction of second and third anal veins, media farther back toward apex.

COLOR CHARACTERISTICS. Greyish-testaceous, darkly infuscated; elytra greyish-hyaline, veins whitish, sparingly marked with large blackish-fuscous spots, costal cell broadly whitish, but always a few fuscous spots on costa. Wings smoky to hyaline, veins darker. Beneath greyish-testaceous, guttate with brownish; fore and middle tibiæ twice banded with brownish. Vertex shining, a dark crescentric spot anteriorly, interrupted in center. Front and lateral compartments of process pale yellowish, immaculate. Sides of pronotum irrorate with blackish fuscous, a piceous-black indented spot each side of median carina on central disc. Scutellum guttate with blackish-fuscous laterally, a pair of piceous-black indented points apically. Tegulæ darkly clouded with fuscous. A large piceous-black spot between ventral extremity of postocular process and eye, another behind each antenna, prolonged to postocular process, and a third ventrad of center of epipleura.

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* Van Duzee, E. P. Catalog of The Hemiptera: II Homoptera.

LENGTH. From sulcus to tip of telson, male and female 5.6 mm.; process, 1.6 to 2 mm.; greatest width 2.6 mm.

LOCALITY RECORDS. Arizona, Colorado, District of Columbia, *Florida, Illinois, Kansas,* Maryland, Massachusetts, *Mississippi,* New Jersey, New York, North Carolina, South Carolina, *Virginia.* A fine series of specimens were present on which to base the redescription. Italics indicates those locality records not listed by Van Duzee. The Arizona record is questionable and perhaps comes from the fact that *S. snowi* sp. n. has been called *S. perdix* Uhler.

Scolops stonei sp. n.

(Pl. LXIII, Figs. 8, 8a.)

In many respects resembling *S. uhleri* Ball, but much less robust, the elytra longer and narrower apically, which results in a more slender and apparently longer insect.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process long and slender, longer than front in ratio of seven to five, two-thirds as wide as vertex when measured at sulcus, nearly parallel-margined, straight; tip truncate, polished. Vertex convex, narrow, highly polished; caudal margin faintly carinate, straight; lateral margins carinate, broadly arcuated laterally over eyes, prominently sinuate in front of eyes, then continuing on process nearly parallel to tip. Margins of front subparallel, carinate, sinuate slightly mesad between eyes, constricted somewhat to sulcus, continuing on process diverging a little toward tip; five carinæ equally prominent, median carina ending at sulcus. Lateral margins of pronotum carinate, straight; submarginal carinæ becoming obsolete anteriorly; caudal margin prominently arcuated anteriorly, scarcely incised at center; central disc broader than long in ratio of seven to six; lateral margins carinate, straight, broadly converging anteriorly, median carina prominent. Scutellum broader than long in ratio of eight to seven, lateral margins of disc carinate, median carina nearly obsolete. Cubitus and media forking unequally, cubitus near junction of second and third anal veins, media well back toward apex

COLOR CHARACTERISTICS. Greenish-white, heavily marked with blackish-fuscous. Vertex shining, a blackish-fuscous crescent anteriorly, interrupted in center. Front and ventral compartments of process pale, a little guttate with brownish; sides of process much darkened with blackish-fuscous, latero-dorsal carinæ broadly whitish, a blackish-fuscous strip between. Sides of pronotum heavily guttate with blackish-fuscous, a large, round, piceous-black spot on central disc each side of median carina. Scutellum guttate with fuscous laterally; central disc mostly pale, a pair of blackish indented points near apex. Tegulæ darkly clouded with fuscous. Elytra heavily marked with blackish-fuscous; veins lighter, interrupted with blackish-fuscous points; costa broadly white, unmarked. A large, piceous-black spot between postocular process and eye, another behind each antenna prolonged to that between postocular process and eye, a third ventrad of center of epipleura represented only by indentation. Epipleuræ heavily and darkly infuscated. Beneath guttate with fuscous. Fore and middle tibiæ twice banded fuscous.

LENGTH. From sulcus to tip of telson, male 5.5 mm., female 6 mm.; process, male 2 mm , female 2.5 mm.; greatest width, male 2.3 mm., female 3 mm.

Described from 24 specimens—20 from Sanford, Fla , E. D. Ball; 2 from Biloxi, Miss., C. J. Drake; 1 from Wilmington, N. C., Osborn and Metcalf; and 1 from Georgia in the P. R. Uhler collection; 16 males and 8 females. Holotype, male; allotype and paratypes in the entomological collections of the University of Kansas, paratype No. 41,346 in the collections of the National Museum, paratype in the collection of Z. P. Metcalf, and paratypes in the collection of E. D. Ball.

Scolops snowi sp. n.

(Pl. LXIII, Figs. 9, 9a.)

Resembling *S. perdix* Uhler, but lighter and more robust, with a longer and stouter process; elytra dark, fusco-hyaline, veins obsoletely and sparingly interrupted with whitish; costal border broader and whiter, lacking the blackish-fuscous flecks found in that species.

STRUCTURAL CHARACTERISTICS. Head constricted behind eyes. Cephalic process long, slender, straight, five-sevenths as wide as vertex when measured at sulcus, longer than front in ratio of five to four, sides converging anteriorly; tip truncate, polished. Vertex somewhat convex; caudal margin carinate, straight; median carina nearly obsolete; lateral margins carinate, acute, arcuated laterally over eyes, sinuate in front of eyes, and continuing on process nearly parallel to tip. Margins of front converging anteriorly, sinuate mesad between eyes, abruptly constricted at sulcus, and continuing on process straight to tip; five carinæ equally prominent, median carina ending at sulcus. Lateral margins of pronotum carinate, slightly sinuate; submarginal carinæ bending back and joining lateral margins of disc near posterior end; caudal margin broadly arcuated anteriorly; central disc broader than long in ratio of four to three; lateral margins carinate, slightly sinuate mesad; median carina prominent. Scutellum broader than long in ratio of four to three; lateral margins of central disc carinate, median carina nearly obsolete. Cubitus and media forking unequally, cubitus near junction of second and third anal veins, media well back toward apex.

COLOR CHARACTERISTICS. Elytra dark, fusco-hyaline, veins obsoletely and sparingly interrupted with whitish, a large, blackish-fuscous spot just anterior to junction of cubitus and media, a row of blackish-fuscous spots on apical margins, costa broadly white, unmarked. Wings white to brownish, veins darker. Beneath pale, yellowish-green, guttate with brownish; fore and middle tibiæ twice banded with brown. Vertex shining, a dark crescentric spot anteriorly, interrupted in center. Lateral compartments of front guttate with brownish, those of process uniformly dark brown; central compartments of front and process pale yellowish, immaculate. Sides of pronotum somewhat granulose, guttate with blackish-fuscous; a small black spot each side of median carina of central disc; another somewhat crescent-shaped, against each lateral margin on outer side next eye. Scuttellum guttate with brownish; a pair of small, blackish-fuscous points near apex. A prominent blackish-fuscous spot between ventral extremity of postocular process and eye, another behind each antenna prolonged to postocular process, and a third ventrad of center of epipleura.

LENGTH. From sulcus to tip of telson, male 5 mm., female 6 mm.; process, 1.7 mm.; greatest width, male 2.3 mm., female 3 mm.

Described from 8 specimens from southern Arizona, F. H. Snow; and 4 specimens from Logan canyon, Utah, 2 from Richfield, Utah, and 2 from Soldier, Utah, E. D. Ball; 10 males and 6 females. Holotype, male; allotype and paratypes deposited in the entomological collections of the University of Kansas; paratypes in the collection of E. D. Ball.

Scolops robustus Ball.

(Pl. LXIV, Figs. 1, 1a.)

Ball. Can. Ent.; XXXIV, p. 150; 1902.
Cockerelli Fowler. Biol. Centr. Am., Homop.: I, p 122; 1904; *Ornithissus*.

Body distinctly broadly oval, of a grayish-testaceous color; cephalic process very short and slender, about half as long as front and not over half as wide as vertex when measured at sulcus, tapering slightly anteriorly, straight.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process short, slender, straight; sides nearly parallel, constricted at immediate tip; tip truncate, polished. Vertex very moderately convex, caudal margin not carinate, median carina obsolete; lateral margins carinate, acute, flattened laterally over eyes, abruptly constricted till over sulcus, then continuing on process nearly parallel to tip. Margins of front converging anteriorly, abruptly constricted to sulcus, continuing on process nearly parallel to tip; five carinæ of front equally prominent, median carina ending at sulcus. Lateral margins of pronotum carinate, broadly rounded, submarginal carinæ becoming obsolete anteriorly; caudal margin broadly arcuated anteriorly, very slightly incised at center; central disc broader than long in the ratio of four to three, lateral margins convergingly curved anteriorly, median carina prominent. Scutellum broader than long in ratio of five to three, lateral margins of central disc carinate, median carina usually obsolete or nearly so. Cubitus and media of corium usually forking equally near junction of second and third anal veins.

COLOR CHARACTERISTICS. Greyish-testaceous above and below, more or less guttate with brownish; elytra yellowish-hyaline, irregularly marked with fuscous blotches along veins; veins prominent, lighter, seldomly interrupted with blackish fuscous, conspicuously lighter anterior to forking of cubitus and media; costal vein and cell mostly whitish, basal half of costal cell suffused with brown toward base; wings whitish, diaphanous. Fore and middle tibiæ banded with fuscous. Vertex shining, a pair of small blackish spots anteriorly. Process greenish or smoky, the carinæ pale. Lateral compartments of front and process guttate with brown which becomes denser and darker anteriorly, central compartments unmarked. Pronotum distinctly lighter, sides marked with blackish-fuscous spots, a large, round, pitch-black spot each side of median carina of central disc. Scutellum guttate with blackish-fuscous laterally, central disc pale yellowish, a pair of blackish indented points near apex. A small, round, blackish-fuscous spot between ventral extremity of postocular process and eye. Epipleura heavily guttate with blackish-fuscous.

LENGTH. From sulcus to tip of telson, male 4.3 to 4.6 mm., female 5.3 mm.; process, male 1 mm., female 1.15 mm.; greatest width, male 2.3 mm., female 2.6 mm.

The writer had before him specimens from Arizona, Colorado, Kansas, Nebraska, Texas and Utah. To this list must be added Mexico, the type locality of Fowler's *cockerelli*. The only locality record listed by Van Duzee for Ball's *robustus* is Colorado. The series of specimens used in writing this description contained 6 cotype specimens of *S. robustus* Ball. Elsewhere in this paper the synonymy of these species has been adequately discussed.

Scolops pruinosus sp. n.

(Pl. LXIV, Figs. 2, 2a.)

Resembling *S. robustus* Ball in form and somewhat in appearance, but larger and lighter, with a longer and stouter process, and covered with a distinct pruinosity that persists.

STRUCTURAL CHARACTERISTICS. Head somewhat constricted behind eyes. Cephalic process short and stout, three-fourths as wide as vertex when measured at sulcus, shorter than front in ratio of eight to eleven, and tapering but slightly to tip; tip truncate, transversely carinate on dorsal margin. Vertex slightly convex, shining; caudal margin straight, slightly carinate; median carina present, obtuse, sometimes appearing to extend as faint light line on process; lateral margins carinate, prominent, slightly arcuated laterally over eyes, sinuate in front of eyes, and continuing on process nearly parallel tip to tip; tip transversely carinate on dorsal margin. Margins of front subparallel, carinate, abruptly constricted to sulcus; five carinæ equally prominent, median carina fading out at sulcus. Lateral margins of pronotum carinate, straight; submarginal carinæ bending back to lateral margins of disc at centers; caudal margin broadly arcuated anteriorly; central disc broader than long in ratio of four to three, lateral margins carinate, arcuated laterally, median carina prominent. Scutellum broader than long in ratio of five to three; margins of central disc carinate, median carina present. Cubitus and media forking about equally near junction of second and third anal veins, $media_{3+4}$ forking again before apex.

COLOR CHARACTERISTICS. Light straw yellow, faintly guttate with fuscous, elytra covered with a silvery pruinosity; the large, round, pitch-black spots on disc of pronotum conspicuous; beneath, pale, guttage with faint brownish. Vertex shining, a blackish-fuscous spot each side of median carina anteriorly. Lateral compartments of front and process made darker by irregular patches and spots of blackish-fuscous, which increases in density toward tip of process, making it much darker laterally and anteriorly. Central compartments of process pale, immaculate. Sides of pronotum irregularly marked with blackish-fuscous; a large, round, piceous-black spot on central disc each side of median carina, another of irregular shape against each lateral margin on outer side next eye. A pair of black, indented points near apex of scutellum; sides of scutellum irregularly marked with blackish-fuscous. A prominent black spot between ventral extremity of postocular process and eye, another behind each antenna, and a third ventrad of center of epipleura. Veins of elytra concolorous, margined each side with faint, irregularly placed, fuscous spots, a row of fuscous dots on apical margin; costal border broadly white, unmarked. Fore and middle tibiæ faintly twice banded with fuscous.

LENGTH. From sulcus to tip of telson, male 5.3 mm., female 7 mm.; process 1.6 mm.; greatest width, male 2.6 mm., female 3.3 mm.

Described from 7 specimens taken at Wray and Julesburg, Colo., E. D. Ball; 2 males and 5 females. Holotype, male; allotype and paratypes deposited in the entomological collections of the University of Kansas, paratypes in the collection of E. D. Ball, and paratype in the collections of the Colorado State Agricultural College. The silvery pruinosity of this insect seems to be a unique character for the genus.

Scolops viridis Ball.

(Pl. LXIV, Figs. 8, 8a.)

Ball. Can. Ent.: XXXIV, p. 149; 1902.

Cephalic process long and very slender, parallel-margined; of much the same form as *S. perdix* Uhler, but larger; color light green, veins of elytra marked with pale smoky spots.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process long and slender, a little longer than front and not more than half as wide as vertex when measured at sulcus, parallel-margined, sometimes appearing a little inflated at tip; tip truncate, polished. Vertex broad, convex, polished; caudal margin faintly carinate, straight; lateral margins carinate, acute, nearly straight, subparallel, converging till over sulcus, then diverging a little and continuing on process parallel to tip. Margins of front nearly straight, subparallel, faintly carinate, abruptly constricted to sulcus and continuing on process nearly parallel to tip; three middle carinæ equally prominent, median carina ending at sulcus. Pronotum somewhat wrinkled, lateral margins faintly carinate, broadly rounded; submarginal carinæ becoming obsolete anteriorly; caudal margin broadly arcuated anteriorly, incised at center; central disc broader than long in ratio of four to three; lateral margins carinate, straight, converging a little anteriorly, median carina present, obtuse. Scutellum broader than long in ratio of four to three; lateral margins of central disc carinate, median carina only indicated. Cubitus and media usually forking about equally near junction of second and third anal veins.

COLOR CHARACTERISTICS. Light green, irrorate with smoky-fuscous; veins of elytra bright green, alternately interrupted with whitish and pale smoky-fuscous; costa very pale green, unmarked. A pair of black spots on disc of pronotum, another on scutellum apically. Wings whitish, diaphanous.

LENGTH. From sulcus to tip of telson, male 5 mm., female 5.6 mm.; process 1.6 to 2 mm.; greatest width 2.6 mm.

Description based on numerous specimens from Colorado and Utah, including 5 cotypes. The Utah record is additional to that listed by Van Duzee.

Scolops austrinus sp. n.

(Pl. LXIV, Figs. 4, 4a.)

Resembling S. *robustus* Ball somewhat in appearance, but lighter, and larger, with longer wings which results in a less globular appearance, and with a much longer process.

STRUCTURAL CHARACTERISTICS. Head constricted behind eyes. Cephalic process long, slender, less than half as wide as vertex measured at sulcus, as long as front, parallel-sided, and usually bent upward; tip truncate, polished. Vertex convex, broad, highly polished; caudal margin slightly carinate at extremities; median carina obsolete; lateral margins carinate, prominent, arcuated laterally over eyes, prominently sinuate in front of eyes, and continuing on process parallel to tip. Margins of front somewhat carinate, converging anteriorly, abruptly constricted to sulcus, continuing on process straight to tip; three carinæ of front equally prominent, median carina of front continuing beyond sulcus for a short distance. Lateral margins of pronotum carinate, straight; submarginal carinæ bending back toward lateral margins of central disc; caudal margin broadly arcuated anteriorly, incised at center; central disc as broad as long; lateral margins carinate, broadly converging anteriorly, median carina prominent. Scutellum broader than long in ratio of five to three; central disc flat, lateral margins somewhat carinate, median carina absent. Cubitus and media forking somewhat unequally near junction of second and third anal veins, media before cubitus.

COLOR CHARACTERISTICS. Pale straw yellow or tarnished ivory, lightly guttate with brownish and sparingly marked with blackish-fuscous. Vertex glossy, a blackish-fuscous spot anteriorly, usually interrupted in center. Front and ventral compartments of process pale, nearly immaculate; lateroventral carinæ of process dark, broadly bordered with blackish-fuscous; latero-dorsal carinæ broadly light, a blackish-fuscous strip between. Sides of pronotum heavily marked with blackish-fuscous; a large, round, piceous-black spot on central disc each side of median carina. Scutellum guttate with fuscous laterally; central disc pale, unmarked, except for pair of blackish indented points near apex. Tegulæ clouded with fuscous. A large, piceous-black spot between postocular process and eye, another behind each antenna, prolonged to dark markings on pronotum, a third that varies in prominence ventrad in center of epipleura. Veins of elytra lighter, concolorous, usually margined each side with minute fuscous spots; apical areoles heavily marked with brownish. Wings fusco-diaphanous, veins lighter. Fore and middle tibiæ heavily twice banded with blackish-fuscous.

LENGTH. From sulcus to tip of telson, male 5 mm., female 6 mm.; process, male 1.15 mm., female 1.3 mm.; greatest width, male 2.6 mm., female 3 mm.

Described from 5 specimens from Tucson, Ariz., F. H. Snow; 2 from Tucson, Ariz., C. N. Ainslie, in the collection of Herbert Osborn; and 9 from Nogales, Ariz., F. W. Nunenmacher, in the collection of W. J. Gerhard; 8 males and 8 females. Holotype, male; allotype and paratypes deposited in the entomological collections of the University of Kansas. Paratypes in the collections of Herbert Osborn and W. J. Gerhard.

Scolops pungens (Germar).

(Pl. LXIV, Figs. 5, 5a.)

Germar. Thon's Ent. Archiv.: II, p. 47; 1830; *Flata.*
Spurcus Uhler. Trans. Md. Acad. Sci.: I, p. 403; 1900.
Desiccatus Uhler. Trans. Md. Acad. Sci.: I, p. 407; 1900.
Parvulus Metcalf. Jl. Elisha Mitchell Sci. Soc.; XXXVIII, p. 175; 1923.

Brachypterous form broadly oval; macropterous form elongate, elytra nearly parallel-margined, flaring posteriorly; process long, stout, upturned; color, dull, smoky-whitish to greyish-testaceous, evenly peppered with dark fuscous points.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process long, usually longer than front in ratio of six to five, stout, not more than three-fourths as wide as vertex when measured at sulcus, upturned, tapering gently toward tip. Vertex convex, shining; caudal margin not carinate; lateral margins carinate, prominent, arcuated laterally over eyes, sinuate in front of eyes, diverging till over sulcus, then converging again and continuing on process subparallel to tip; tip truncate, polished, transversely carinate on dorsal margin. Margins of front nearly straight, converging anteriorly, abruptly constricted to sulcus and continuing on process converging a little to tip; five carinæ of front equally prominent, median carina ending at sulcus. Lateral margins of pronotum carinate, broadly rounding anteriorly; submarginal carinæ becoming obsolete anteriorly; caudal margin broadly arcuated anteriorly, incised at center; central disc broader than long in ratio of four to three; lateral margins carinate, converging rapidly anteriorly; median carina present, prominent. Scutellum broader than long in ratio of four to three; lateral margins of central disc usually carinate, median carina sometimes present, usually indicated. Cubitus and media branching about equally near junction of second and third anal veins, media usually a little anterior to cubitus.

COLOR CHARACTERISTICS. Dull, smoky-whitish to greyish-testaceous, fresh specimens often showing greenish, evenly peppered above and below with minute, dark, fuscous flecks, which vary greatly in density, causing some specimens to appear almost black, others a solid yellow. Veins of elytra saddled with small fuscous markings of even distribution. Vertex shining, infuscated anteriorly, sometimes entirely darkened. Brownish marks on pronotum increase in density laterally resulting in piceous-black callosities behind eyes. All geminate indentations present, pitch-black.

LENGTH. From sulcus to tip of telson, male 4.6 to 6 mm., female 5.3 to 6.3 mm.; process, male 1.15 to 2 mm., female 1.6 to 2.3 mm.; greatest width, male 2.3 to 3 mm., female 2.6 to 3.3 mm.

The above description is based on a very long series of specimens from various parts of the United States and Mexico. The Mexican record consists in a specimen taken at Monterey, Mexico, in the entomological collections of the Illinois Natural History Survey. The synonymy of this species has been adequately discussed elsewhere.

LOCALITY RECORDS. *Colorado,* District of Columbia, Florida, *Illinois,* Indiana, *Iowa,* Kansas, *Kentucky, Louisiana,* Maryland, *Mexico, Mississippi,* Missouri, *Nebraska,* New Jersey, North Carolina, *North Dakota,* Ohio, *Pennsylvania, South Carolina,* Texas, *Wisconsin.* Italics indicates locality records not listed by Van Duzee.

Scolops hesperius Uhler.

(Pl. LXIV, Figs. 6, 6a.)

Uhler. Bul. U. S. Geol. Geog. Surv.: I, p. 349; 1876.

Cephalic process short and very stout, tapering anteriorly, bent upward; form robust; color pale yellowish, veins of elytra dotted with fuscous.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process short and stout, shorter than front and as wide, or wider, than vertex when measured at sulcus. Vertex scarcely convex, slightly wrinkled, median carina sometimes indicated; caudal margin faintly carinate, arcuated a little anteriorly; lateral margins prominently carinate, nearly straight, continuing on process converging to tip. Lateral margins of front nearly straight, carinate, sinuate a little mesad between eyes, subparallel, constricted a little to sulcus, continuing on process converging a little toward tip; three median carinæ of front equally prominent, median carina ending at sulcus. Pronotum granulose; lateral margins carinate, broadly rounded; submarginal carinæ becoming obsolete anteriorly; caudal margin broadly arcuated anteriorly, incised at center; central disc as broad as long; lateral margins carinate, nearly straight, sinuate a little mesad, converging anteriorly; median carina present, acute. Scutellum smooth, broader than long in ratio of three to two, lateral margins carinate, median carina usually indicated. Cubitus and media forking equally near junction of second and third anal veins.

COLOR CHARACTERISTICS. Pale yellowish, more or less tinged with fuscous; geminate indentations present, but uncolored; front and process pale yellowish, sometimes yellowish-green, unmarked; eyes usually reddish; legs longitudinally striped with fuscous; pronotum and scutellum somewhat guttate with fuscous; veins of elytra dotted and spotted with fuscous; wings white.

LENGTH. From sulcus to tip of telson, male 6 mm., female 6.6 mm.; process, 1.6 mm.; greatest width, 3 mm.

In describing this species specimens have been examined from California, Colorado, *Kansas, Montana, North Dakota, South Dakota,* and Texas. In addition to this list Van Duzee adds Idaho. Italics indicate locality records not listed by Van Duzee.

Scolops vanduzei Ball.

(Pl. LXIV, Figs. 7, 7a.)

Ball. Can. Ent.: XXXIV, p. 150; 1902.

Cephalic process long and very stout, bent upward; form broadly oval; color yellowish-testaceous, veins of elytra light, margined each side with narrow nearly continuous fuscous stripes.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process long and stout, as long as front and very nearly as wide as vertex when measured at sulcus. Vertex convex; median carina present, obtuse; caudal margin slightly carinate, straight; lateral margins carinate, acute, arcuated laterally over eyes and continuing on process converging a little toward tip; tip truncate, transversely carinate on dorsal margin. Lateral margins of front carinate, subparallel, constricted a little to sulcus, then continuing on process parallel to tip, abruptly converged at immediate tip; five carinæ of front equally prominent; median carina continuing on process to tip, faint. Pronotum a little granulose; lateral margins carinate, broadly rounded; submarginal carinæ bending back to lateral margins of central disc caudad of centers; caudal margin broadly arcuated anteriorly, incised at center; central disc broader than long in ratio of four to three, lateral margins carinate, nearly straight, converging anteriorly; median carina present, acute. Scutellum broader than long in ratio of four to three; margins of central disc carinate, median carina only indicated. Cubitus and media forking unequally cubitus near junction of second and third anal veins, media usually a little farther back on corium.

COLOR CHARACTERISTICS. Yellowish-testaceous, a little guttate with fuscous. Vertex shining, a piceous-black crescentic spot anteriorly; a pair of small deeply indented points, piceous-black in color, on disc of pronotum, another on scutellum apically. A piceous-black spot between postocular process and eye, another behind each antenna, minute, and a third ventrad of center of epipleura. Front pale yellowish, immaculate; lateral compartments of process guttate with blackish-fuscous which increases in density anteriorly. Legs longitudinally striped with fuscous. Veins of elytra concolorous, margined each side with narrow, nearly continuous stripes. Wings white, diaphanous.

LENGTH. From sulcus to tip of telson, male 5 mm., female 6 mm.; process, 1.6 mm.; greatest width, 2.6 mm.

Description based on specimens from *Colorado* and Nebraska, including 4 cotypes. A specimen from Colorado is unusually dark due to an increase in the density of the fuscous markings. The Colorado record is an addition to the record given by Van Duzee.

Scolops luridus sp. n.

(Pl LXV, Figs 1, 1a)

Resembling *S. hesperius* Uhler somewhat in form and appearance, but lighter and larger, distinctly lurid, nearly concolorous, a few dark markings in apical areas of elytra, and with a longer and stouter process.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process long, as long as front, and as wide as vertex when measured at sulcus, straight, appearing somewhat inflated; tip truncate, polished. Vertex very slightly convex, finely wrinkled; caudal margin straight, carinate; median carinate; median carina present, obtuse; lateral margins carinate, acute very slightly arcuated laterally over eyes, sinuate in front of eyes, and continuing on process nearly parallel to tip. Margins of front somewhat carinate, nearly parallel, constricted somewhat to sulcus, diverging anteriorly on process and converging again near tip, producing an inflated appearance; three carinæ equally prominent; median carina continuing on process nearly to tip. Lateral margins of pronotum somewhat carinate, straight; submarginal carinæ bending back and joining lateral margins of central disc caudad of center; caudal margin narrowly arcuated anteriorly, incised at center; central disc nearly as broad as long; lateral margins carinate, nearly parallel, convergingly rounded anteriorly; median carina prominent. Scutellum broader than long in ratio of three to two; margins of central disc carinate, median carina nearly obsolete. Cubitus and media forking about equally near junction of second and third anal veins.

COLOR CHARACTERISTICS. Brightly lurid above and below, very nearly concolorous, often with reddish or greenish casts, eyes distinctly reddish, veins of elytra concolorous, fuscous areas limited to faint, narrow bands bordering longitudinal veins and to apical areoles. Costa broadly white, unmarked. Wings smoky; veins dark, bordered with white.

LENGTH. From sulcus to tip of telson, male 6 mm., female 7 mm.; process, male 1.6 mm., female 2 mm.; greatest width, male 3 mm., female 3.3 mm.

Described from 18 specimens mostly from Sumner county, Kansas, E. P. Breakey; and 2 from Riley county, Kansas, G. A. Dean; 14 males and 6 females. Holotype, male; allotype and paratypes deposited in the entomological collections of the University of Kansas, and paratypes in the entomological collections of the Kansas State Agricultural College. The nearly concolorous appearance of this species together with its lurid color, its large size, and inflated appearance of its process, ought to aid materially in its determination.

Scolops flavidus sp. n.

(Pl. LXV, Figs. 2, 2a.)

Of much the same appearance as *S. luridus* Breakey, but smaller and lighter, with a long and stout process that tapers rapidly to the tip, giving it a pointed appearance.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process long and stout, longer than front in ratio of six to five, three-fourths as wide as vertex when measured at sulcus, straight, sides converging rapidly to tip; tip narrowed almost to vertical, obtuse carina. Vertex nearly flat, very finely wrinkled; caudal margin straight, somewhat carinate; median carina scarcely visible; lateral margins carinate, acute, nearly straight, converging slightly anteriorly, flattened laterally over eyes, and continuing on process straight to tip. Margins of front carinate, nearly straight, constricted somewhat beyond sulcus, and continuing on process as rapidly converging, straight lines to tip; submarginal carinæ paralleling those of margins to sulcus, then diverging somewhat to tip; median carina becoming obsolete on process. Lateral margins of pronotum somewhat carinate, straight; submarginal carinæ becoming obsolete anteriorly; caudal margin broadly arcuated anteriorly, incised at center; central disc broader than long in ratio of four to three; lateral margins carinate, nearly straight, broadly converging anteriorly, often slightly sinuate mesad in posterior half; a carina originating from each at this point, projecting mesad, and becoming obsolete near median keel. Scutellum broader than long in ratio of five to three; margins of central disc carinate, median carina nearly obsolete. Cubitus and media forking unequally, the points of branching forming an oblique line across corium with junction of the second and third anal veins.

COLOR CHARACTERISTICS. Pale yellow, almost completely devoid of darker markings. The most nearly concolorous species yet known for the genus. Some specimens with a fuscous cloud near the origin of media and cubitus.

LENGTH. From sulcus to tip of telson, male 5.3 mm., female 6.3 mm.; process, male 1.6 mm., female 2 mm.; greatest width, male 3 mm., female 3.6 mm.

Described from 7 specimens from Eugene, Oregon, J. A. Hyslop, 4 males and 3 females, in the collection of Herbert Osborn. Allotype and paratypes in the entomological collections of the University of Kansas.

Scolops flavidus var. *pellos* var. n.

(Pl. LXV, Figs. 5, 5a.)

Resembling *S. flavidus* Breakey somewhat in form, but smaller, and in general appearance darker, the pale yellowish body presenting a marked contrast to the dark, reddish-brown elytra.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process of male short, shorter than front in ratio of two to three, stout, three-fourths as wide as vertex when measured at sulcus, straight; that of female long, longer than front in ratio of five to three; stout, very nearly as wide as vertex when measured at sulcus, straight. Vertex nearly flat; caudal margin carinate, straight; median carina present, obtuse, continuing on process as light line; lateral margins carinate, acute, nearly straight, sinuate in front of eyes, continuing on process straight to tip, converging at immediate tip; tip truncate, polished. Margins of front nearly straight, carinate, subparallel, somewhat sinuate between eyes, constricted slightly to sulcus, and continuing on process nearly parallel to tip. Lateral margins of pronotum somewhat carinate, broadly rounded, submarginal carinæ becoming obsolete anteriorly; caudal margin broadly arcuated anteriorly, and incised at center. Central disc very nearly as broad as long; lateral margins carinate, sinuate mesad in posterior half, a carina originating from each at this point, projecting mesad, and becoming obsolete near median keel. Scutellum broader than long in ratio of four to three, margins of central disc carinate, median carina nearly obsolete. Cubitus and media forking unequally, cubitus near junction of second and third anal veins, media farther back on corium.

COLOR CHARACTERISTICS. Body mostly of a bright, pale straw yellow; elytra of a bright, nearly uniform, reddish-brown; costa broadly yellowish-white, unmarked. Lateral and dorsal surfaces of process stained with reddish-brown, which increases in density anteriorly. Legs somewhat stained with reddish-brown. Wings uniformly whitish, diaphanous.

LENGTH. From sulcus to tip of telson, male 4.6 mm, female 5.3 mm.; process, male 1 mm., female 2 mm.; greatest width, male 2.6 mm., female 3 mm.

Described from two specimens from Eugene, Ore., J. A. Hyslop, in the collection of Herbert Osborn. Holotype, male; holotype in the collection of Herbert Osborn, allotype in the entomological collections of the University of Kansas. The reddish-brown elytra of this insect on the bright, yellowish body, together with the marked structural differences in the process of the sexes, should aid materially in its determination.

Scolops osborni Ball.

(Pl. LXV, Figs. 4, 4a.)

Ball. Can Ent.: XXXIV, p. 147; 1902.

Largest species of the genus; form broadly oval; color very pale yellowish; cephalic process very long and stout, bent upward, and tapering anteriorly to a thick point.

STRUCTURAL CHARACTERISTICS. Head constricted behind eyes. Cephalic process long and stout, a little longer than front, as wide as vertex when measured at sulcus, and regularly tapering anteriorly. Vertex convex, slightly wrinkled, median carina present, obtuse; caudal margin carinate straight; lateral margins carinate, prominent, arcuated a little laterally over eyes, continuing on process converging to tip. Lateral margins of front straight, subparallel, constricted a little to sulcus and continuing on process, converging a little toward tip. Lateral margins of pronotum carinate, slightly sinuate mesad; submarginal carinæ becoming obsolete anteriorly; caudal margin broadly arcuated anteriorly, incised at center; central disc as broad as long, lateral margins carinate, sinuate mesad at centers, broadly rounding anteriorly, median carina present, acute. Scutellum broader than long in ratio of three to two; lateral margins of central disc carinate, carinæ abruptly bent mesad and united anteriorly; median carina wanting. Veins of elytra doubly furcate, reticulations numerous apically.

COLOR CHARACTERISTICS. Elytra pale yellowish, veins concolorous, margined each side with regularly placed pairs of fuscous dots. Wings whitish, veins darker. Beneath yellowish, heavily infuscated. Fore and middle tibiæ twice banded with blackish-fuscous. Front and process yellow, nearly immaculate; pronotum and scutellum yellowish, tinged with green, lightly infuscated; a large pitch-black spot behind each eye of nearly same diameter as eye, a transverse series of four small pitch-black spots on scutellum, arcuated posteriorly. Tegulæ infuscated.

LENGTH. From sulcus to tip of telson, male 7 mm., female 10 mm.; process, 2.3 mm.; greatest width, 3.3 to 3.6 mm.

Description based on a fine series of specimens from Kansas and *Nebraska*. In his original description of the species Ball records Ohio as a locality record. The Nebraska record is an addition to the records given by Van Duzee.

Scolops sulcipes (Say).

(Pl. LXV, Figs. 8, 8a)

Say. Jl. Acad. Nat. Sci Phila : IV, p. 335; 1825; *Fulgora*.

Cephalic process very long, upturned, tapering to a slender point; elytra densely reticulated apically; color grayish-testaceous to reddish-brown; veins of elytra lighter, margined each side with blackish-fuscous bands.

STRUCTURAL CHARACTERISTICS. Head constricted behind eyes. Cephalic process long, longer than front in ratio of five to seven, nearly as wide as vertex when measured at sulcus, sides nearly straight and converging anteriorly to a slender point. Margins of front carinate, usually straight, subparallel; five carinæ of front equally prominent, median carina ending at sulcus. Vertex scarcely convex, shining; caudal margin faintly carinate at extremities; lateral margins carinate, straight, converging anteriorly and continuing on process nearly straight to tip. Lateral margins of pronotum carinate, broadly rounded anteriorly; submarginal carinæ becoming obsolete anteriorly; caudal margin arcuated narrowly anteriorly, incised at center; central disc narrow, a little more than three-fourths as broad as long, lateral margins carinate, nearly parallel, sinuate mesad near centers; median carina present, acute. Scutellum broader than long in ratio of five to three, margins of central disc carinate, median carina only indicated. Brachypterous form broadly oval; macropterous form elongate-oval, elytra nearly parallel-margined, flaring posteriorly.

COLOR CHARACTERISTICS. Heavily infuscated above and below. Cephalic process blackish-fuscous, carinæ pale yellowish. A pair of blackish-fuscous points on vertex anteriorly, another on disc of pronotum, and a third apically on disc of scutellum. A large piceous-black callosity behind each eye, and a smaller one behind each antenna; piceous-black spots between postocular processes and eyes and ventrad of centers of epipleuræ. Fore and middle tibiæ twice banded with blackish-fuscous. Veins of elytra concolorous, margined each side with blackish-fuscous bands.

Length. From sulcus to tip of telson, male 4.6 to 6 mm., female 6-7 mm.; process, 1.6 to 2 mm.; greatest width, male 2.6 to 3 mm., female 3-4 mm.

The above description is based on a very long series of specimens from the United States and Canada.

Locality Records. Arizona, *British Columbia*, Colorado, Connecticut, *District of Columbia*, Florida, Illinois, Iowa, Kansas, Manitoba, Maine, Maryland, Minnesota, Missouri, Nebraska, New Jersey, New York, New Mexico, North Carolina, North Dakota, Ohio, Ontario, *Oregon*, Pennsylvania, Quebec, Rhode Island, Texas, Utah, *Vermont*, Washington, *Wisconsin*. Italics indicate locality records not listed by Van Duzee.

Scolops uhleri Ball.

(Pl. LXV, Figs. 6, 6a)

Ball. Can Ent.: XXXIV, p. 148; 1902.

Cephalic process very long, nearly half longer than front, parallel-margined, about half as wide as vertex when measured at sulcus; form robust; elytra short, broadly rounded apically; general coloring dark brown, longitudinally marked with whitish bars on elytra.

Structural Characteristics. Head constricted behind eyes. Cephalic process long and slender, longer than front in ratio of seven to five, a little wider than vertex when measured at sulcus, parallel-margined; tip truncate, polished. Vertex convex, broad, highly polished; caudal margin not carinate; lateral margins crainate, arcuated laterally ever eyes, sinuate in front of eyes, continuing on process parallel to tip. Margins of front carinate, converging anteriorly, sinuate mesad between eyes, constricted somewhat to sulcus, continuing on process, diverging slightly toward tip, constricted at immediate tip; three carinæ of front equally prominent, median carina ending at sulcus.. Pronotum very short, very broadly arcuated anteriorly; lateral margins faintly carinate, straight; submarginal carinæ becoming absolete anteriorly; central disc broader than long in ratio of four to three; lateral margins carinate, converging anteriorly, sinuate mesad, broadly rounding anteriorly; median carina prominent. Scutellum broader than long in ratio of three to two, lateral margins of disc carinate, median carina obsolete. Elytra broadly rounded apically; cubitus and media forking unequally, both well removed apically from junction of second and third anal veins, media further back.

Color Characteristics. Beneath, pale soiled yellow; above, darker, longitudinally marked with whitish bars. Vertex shining, a blackish-fuscous crescent anteriorly, interrupted in center. Front and ventral compartments of process pale yellowish, a little guttate with fuscous; sides of process much darkened with blackish-fuscous; latero-dorsal carinæ broadly whitish, a dark strip between. Sides of pronotum a little guttate with blackish-fuscous; a large, round, piceous-black spot on central disc each side of median carina. Scutellum guttate with fuscous, a pair of blackish indented points near apex of disc. Tegulæ usually clouded with fuscous. Elytra mostly dark brown; costa and radius broadly white, unmarked; both branches of cubitus and third anal vein broadly white, unmarked; remaining veins broadly dark brown, interrupted with small whitish points. Ventral halves of epipleuræ heavily infuscated. A piceous-black spot between postocular process and eye, a large one of irregular shape behind each antennæ, prolonged dorsally, a third ventrad of centers of epipleuræ. Beneath somewhat infuscated.

LENGTH. From sulcus to tip of telson, male 4.3 mm., female 5 mm.; process, male 2 mm., female 2.3 mm.; greatest width, male 2.3 mm., female 2.6 mm.

The writer had before him specimens from Colorado and Utah, including 4 type specimens. A specimen from Utah is very lightly colored, the fuscous markings being very dim, but the color pattern is typical of the species, and an examination of the genitalia definitely places it systematically.

LOCALITY RECORD. Arizona, Colorado, and Utah. At present the range of the species is limited to the Rocky Mountain states.

Scolops grossus Uhler.

(Pl. LXVI, Figs. 2, 2a.)

Uhler. Bul. U. S. Geol. Geog. Surv.. I, p. 350; 1876.

Cephalic process very stout, rugose, heavily guttate with brownish; form robust; color a rich brown to yellowish; veins of elytra coarse, prominently marked with blackish fuscous.

STRUCTURAL CHARACTERISTICS. Head somewhat constricted behind eyes. Cephalic process short and stout, shorter than front in ratio of five to six, very nearly as wide as vertex when measured at sulcus, somewhat inflated toward tip, constricted at immediate tip, bent upward, rugose; tip prominently vertically carinate. Vertex nearly flat, rugose; caudal margin somewhat carinate, arcuated a little anteriorly; lateral margins carinate, flattened laterally over eyes, sinuate in front of eyes, diverged till over sulcus, continuing on process nearly parallel, then converged at immediate tip. Margins of front carinate; those of female subparallel, those of male converged anteriorly; sinuate mesad between eyes, constricted somewhat to sulcus, continuing on process diverging, then quickly constricted at tip, producing a decided inflated appearance, three carinæ of front equally prominent, median carina continuing on process to tip. Pronotum rugose, the sides a little granulose, lateral margins somewhat carinate, nearly straight, submarginal carinæ bending back toward lateral margins of central disc at posterior ends; caudal margin broadly arcuated anteriorly, incised at center; central disc broader than long in ratio of five to four; lateral margins carinate, straight, convergingly rounded anteriorly, median carina prominent. Scutellum broader than long in ratio of five to four; central disc flat, margins carinate, median carina present. Cubitus and media forking unequally, cubitus near junction of second and third anal veins, media farther back toward apex.

COLOR CHARACTERISTICS. Of a rich brown to yellowish. Front, process, vertex, and pronotum heavily guttate with dark brown; scutellum and elytra clouded with dark brown; veins of elytra prominently marked with blackish fuscous; geminate indentations present, but inconspicuously colored. Beneath, light brown, guttate with darker. Wings smoky brown, veins darker.

LENGTH. From sulcus to tip of telson, male 4.6 mm., female 6.3 mm.; process, male 1.3 mm., female 2 mm.; greatest width, male 2.3 mm., female 3.3 mm.

Specimens are before the writer from western Kansas, eastern Colorado and Texas. This species shows the greatest differences in the relative sizes of the sexes, and is conspicuous for its massive, rugose, dark-colored process.

LOCALITY RECORDS. California, Colorado, Idaho, Kansas, New Jersey and Texas. Some of these records are questionable. It would be surprising if this species occurred in New Jersey, and the writer doubts the authenticity of the California record.

Scolops maculosus Ball.

Pl. LXVI, Figs. 1, 1a).

Ball. Can. Ent.: XXXIV, p. 148; 1902.

Cephalic process long and very stout, bent upward; form narrowly oval; elytra maculate with blackish-fuscous and whitish spots.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process long and stout, as long as front and as wide as vertex when measured at sulcus, usually parallel-margined, sometimes appearing a little inflated at tip. Vertex convex, shining, caudal margin not carinate; lateral margins carinate, acute, arcuated somewhat laterally over eyes, diverging till over sulcus, then converging again and continuing on process parallel to tip: Margins of front straight, somewhat carinate, converging anteriorly, constricted somewhat to sulcus, then continuing on process parallel to tip; three median carinæ of front equally prominent, median carina ending at sulcus. Lateral margins of pronotum somewhat carinate, broadly rounded; submargined carinæ becoming obsolete anteriorly; caudal margin very broadly arcuated anteriorly; incised at center; central disc broader than long in ratio of four to three; lateral margins carinate, usually nearly straight, sometimes a little sinuate mesad near centers, very broadly rounding anteriorly. Scutellum broader than long in ratio of eight to five; lateral margins of central disc carinate, median carina usually only indicated. Media and cubitus forking about equally near junction of second and third anal veins.

COLOR CHARACTERISTICS. Greyish testaceous, guttate with blackish fuscous above and below, elytra maculate with blackish fuscous and whitish, costa broadly white, unmarked. Vertex shining, a blackish-fuscous crescentic spot anteriorly, often interrupted in the center. Front often greenish yellow, lateral compartments of front and process made darker by irregular patches and spots of blackish fuscous which increases in density toward tip of process, making it appear darker laterally and anteriorly; central compartments of front and process unmarked. Sides of pronotum irregularly marked with blackish fuscous; a large, round piceous-black spot each side of median carina on central disc, another between postocular process and eye, a third behind each antenna, and a fourth ventrad of center of epipleura. Scutellum guttate with blackish fuscous laterally, a pair of piceous-black spots on central disc apically. Tegulæ almost black. Veins of elytra alternately interrupted with large blackish-fuscous and whitish spots, a series of blackish-fuscous spots along apical margin. Wings smoky, veins darker.

LENGTH. From sulcus to tip of telson, male 4.6 mm., female 5 mm.; process, 1.6 mm.; greatest width, 2 to 2.3 mm.

Description based on a good series of specimens from Colorado and *New Mexico,* including 5 cotypes. The New Mexican record is additional to that given by Van Duzee.

Scolops immanis sp. n.

(Pl. LXVI, Figs. 8, 8a.)

Resembling *S. grossus* Uhler, but of a less robust form, and lighter, elytra nearly concolorous, the veins lacking the prominent, dark fuscous markings so characteristic of that species.

STRUCTURAL CHARACTERISTICS. Head not constricted behind eyes. Cephalic process short and stout, shorter than front in ratio of four to five, six-sevenths as wide as vertex when measured at sulcus, inflated toward tip, constricted at immediate tip, and bent upward; rugose; tip prominently vertically carinate. Vertex nearly flat, rugose; caudal margin somewhat carinate, arcuated a little anteriorly; lateral margins carinate, nearly straight, flattened laterally over eyes, sinuate in front of eyes, diverging until over sulcus, then converging again toward tip. Margins of front faintly carinate, subparallel, sinuate mesad between eyes, constricted somewhat to sulcus, continuing on process, diverging, then quickly converged at tip, producing a decided inflated appearance; three carinæ of front equally prominent, median carina continuing on process to tip. Pronotum rugose; lateral margins somewhat carinate, straight, submarginal carinæ bending back toward lateral margins of central disc at posterior ends; caudal margin narrowly arcuated anteriorly, incised at center; central disc as broad as long; lateral margins carinate, straight, convergingly rounded anteriorly, median carina prominent. Scutellum broader than long in ratio of four to three, smooth; central disc slightly concave, margins carinate, median carina present. Cubitus and media forking on oblique line with junction of second and third anal veins, cubitus further apically.

COLOR CHARACTERISTICS. Pale brownish to straw yellow. Front, process, vertex, and pronotum greenish. Heavily guttate with dark brown. Scutellum clouded with green and brown. Geminate indentations mostly wanting, only those ventrad of centers of epipleuræ present. Beneath, light brown, guttate with darker; legs heavily guttate with green and brown. Elytra pale brownish, unmarked; veins nearly concolorous, unmarked on male, but sparingly interrupted with minute whitish points on female. Wings diaphanous, veins darker.

LENGTH. From sulcus to tip of telson, male 5 mm., female 6.3 mm.; process, male 1.3 mm., female 1.6 mm.; greatest width, male 2.4 mm., female 3 mm.

Described from 1 male and 2 females from Scott county, Kansas, R. H. Beamer. Holotype, male; allotype and paratype deposited in the entomological collections, University of Kansas.

SYSTEMATIC TREATMENT OF SUBGENUS *BELONOCHARIS.*

SUBGENUS *Belonocharis* Uhler.

Uhler Trans Md Acad Sci . I, p 145; 1891

In describing this group as a genus Uhler named many characters that are not generic, and failed, for the most part, to point out those that could be relied upon to identify the group. Opinions differ greatly as to the amount of variation necessary to warrant the erection of a genus. At present the writer doesn't think that the species now known to belong in this group display enough essential differences to warrant their complete separation from the genus *Scolops.* The principal ways in which these insects differ from *Scolops* are as follows: The plane of the vertex is above that of the pronotum, the eyes are distant from the pronotum, the fore and middle tibiæ are foliaceous, and the genitalia of the males show distinct differences in structure, as will be seen from an examination of the accompanying drawings. That these insects possess simpler structures than those of *Scolops* is shown by the greater simplicity of the male genitalia, and the fact that media is seldom branched before the apex

The following species are recognized as belonging to this group: *S. fumidus* (Uhler), *S. pallidus* Uhler, and *S. abnormis* Ball.

KEY TO THE SUBGENUS *BELONOCHARIS*

PAGE

A Cephalic process slender, less than three-fourths as wide as vertex when measured at sulcus tapering anteriorly, latero-dorsal carinæ broadly white

  B Ground color black, media usually forking before apex of clavus *S fumidus* Uhler, 448

  BB Ground color pale yellowish, media rarely forking before apex of clavus *S pallidus* Uhler, 449

AA Cephalic process stout, as wide, or wider, than vertex when measured at sulcus, inflated all carinæ dark brownish *S abnormis* Ball, 450

Scolops fumidus (Uhler).

(Pl LXVI, Figs 4, 4a)

Uhler Trans Md Acad Sci I, p 146, 1891, *Belonocharis*
Piceus Van Duzee Trans San Diego Soc Nat Hist , II, p 35; 1914

Piceous black, marked with whitish; cephalic process slender and tapering; brachypterous form broadly oval, macropterous form much larger, wings broadly flaring posteriorly.

STRUCTURAL CHARACTERISTICS Head constricted behind eyes, eyes distant from pronotum Cephalic process as long as front or longer, three-fifths as wide as vertex when measured at sulcus, bent upward and tapering anteriorly. Vertex slightly convex, shining; caudal margin very faintly carinate, straight; lateral margins very prominently carinate, nearly straight, converging anteriorly, sinuate mesad in front of eyes, then broadly flattened laterally over sulcus, and continuing on process convergingly straight to tip. Front very broad, much narrowed anteriorly; lateral margins carinate, nearly straight, abruptly constricted to sulcus, then continuing on process subparallel to tip; five carinæ equally prominent, median carina becoming obsolete near sulcus, reappearing again near tip. Pronotum rugose; lateral margins carinate, broadly rounded; submarginal carinæ becoming obsolete anteriorly; caudal margin broadly arcuated anteriorly, incised at center; central disc broader than long in ratio of four to three; lateral margins carinate, sinuate mesad at centers, broadly rounded anteriorly; median carina present, acute. Scutellum broader than long in ratio of seven to five; central disc somewhat concave, lateral margins slightly carinate, median carina obsolete. Media and cubitus forking unequally, cubitus near junction of second and third anal veins, media farther back apically.

COLOR CHARACTERISTICS. Black, marked with whitish; elytra uniformly smoky hyaline, excepting costa which is much darker. Beneath guttate with whitish. Cephalic process piceous black, latero-dorsal and latero-ventral carinæ broadly whitish. Vertex piceous black, shining. Pronotum and tegulæ maculate with whitish. Disc of scutellum broadly whitish mesally and anteriorly. Front broadly whitish ventrally, guttate with whitish anteriorly.

LENGTH. From sulcus to tip of telson, male 4 mm., female 5.6 mm.; process, 1 to 1.3 mm.; greatest width, male 2.3 mm., female 3 mm.

Description based on specimens from California collected and loaned by Dr. E. D. Ball. A discussion of the synonymy of this species occurs elsewhere in this paper.

Scolops pallidus Uhler.

(Pl. LXVI, Figs 5, 5a)

Uhler. Trans. Md. Acad. Sci . I, p. 404; 1900.

Pale yellowish gray, more or less marked with fuscous; cephalic process long and slender, tapering somewhat anteriorly, usually bent upward; form narrowly oval.

STRUCTURAL CHARACTERISTICS. Head constricted behind eyes, eyes distant from pronotum. Cephalic process longer than front, two-thirds as wide as vertex when measured at sulcus, bent upward and tapering somewhat anteriorly. Vertex nearly flat, somewhat rugose; caudal margin faintly carinate, straight; lateral margin prominently carinate, acute, straight, converging till over sulcus, then continuing on process subparallel to tip; five carinæ of front equally prominent, median carina becoming obsolete before sulcus. Pronotum rugose, lateral margins carinate, broadly rounded; submarginal carinæ bending back to lateral margins of central disc near centers; caudal margin narrowly arcuated anteriorly, scarcely incised at center. Scutellum broader than long in ratio of seven to five; central disc somewhat concave, lateral margins carinate, median carina wanting, a pair of large, round, indented points apically. Media not forking before apex, cubitus forking before junction of second and third anal veins.

COLOR CHARACTERISTICS. Pale yellowish gray, more or less infuscated; elytra almost white, the veins usually dotted with fuscous in various degrees of darkness, a fuscous cloud or two apically. Cephalic process blackish fuscous, latero-dorsal carinæ broadly whitish. Vertex heavily infuscated. Pronotum more or less maculate with blackish fuscous. Scutellum pale yellowish gray, guttate with blackish fuscous laterally, a pair of large, round fuscous spots apically. Front and ventral compartments of process pale yellowish, usually guttate with fuscous.

LENGTH. From sulcus to tip of telson, male 4.6 mm., female 5.3 mm.; process, 1.6 to 2 mm.; greatest width, male 2.3 mm., female 2.6 mm.

Description based on specimens from California, Colorado, *Mexico,* and Utah. Van Duzee questions the Colorado and Utah records. Specimens from both places have been studied and that they represent this species is without question. The specimens from Colorado were taken at Rifle, which is on the western slope of the mountains.

Scolops abnormis Ball.

(Pl. LXVI, Figs. 6, 6a.)

Ball. Can. Ent.: XXXIV, p. 149; 1902.

Pale yellowish, guttate with fuscous; cephalic process long and very stout, inflated, bent upward; form broadly oval.

STRUCTURAL CHARACTERISTICS. Head constricted behind eyes, eyes distant from pronotum. Cephalic process longer than front, as wide as vertex when measured at sulcus, or wider, bent upward and inflated somewhat anteriorly. Vertex nearly flat, rugose; caudal margin not carinate, median carina sometimes present; lateral margins very prominently carinate, straight, nearly parallel, continuing on process convergingly straight to tip. Front slender, narrowed anteriorly; lateral margins carinate, straight, constricted a little to sulcus, then continuing on process, diverging a little toward tip, abruptly converged at immediate tip; five carinæ of front equally prominent, median carina becoming obsolete before sulcus. Pronotum rugose; lateral margins carinate, broadly rounded; submarginal carinæ bending back to lateral margins of central disc caudad of centers; caudal margin broadly arcuated anteriorly, scarcely incised at center; central disc broader than long in ratio of four to three, lateral margins carinate, nearly straight, converging anteriorly; median carina present, acute. Scutellum broader than long in ratio of four to three; central disc somewhat concave, lateral margins carinate, roundly converged anteriorly, median carina wanting. Media not forking before apex, cubitus forking near junction of second and third anal veins.

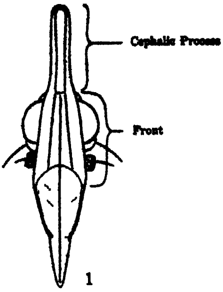
COLOR CHARACTERISTICS. Pale greyish testaceous, body more or less guttate with browish; elytra pale yellowish white, the veins usually dotted and spotted with blackish fuscous, often unmarked. Cephalic process brown, with small, light maculations. Vertex infuscated; a pair of indented points on disc of pronotum, another on scutellum apically, colored to various degrees of darkness. Front pale yellowish, unmarked.

LENGTH. From sulcus to tip of telson, male 5 mm., female 5.6 mm.; process, male 1.6 mm., female 2.6 mm.; greatest width, male 2.3 mm., female 3 mm.

Description based on a fine series of specimens from California, *Washington* and *Oregon.* This species displays a great variation in the density of the fuscous markings, some specimens appearing to be nearly concolorous. Italics indicates locality records not listed by Van Duzee.

PLATES.

PLATE LXIII.



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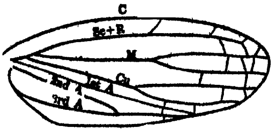

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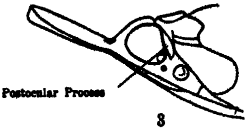

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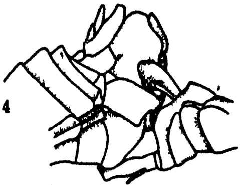

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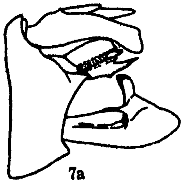
Copulatory Attachment



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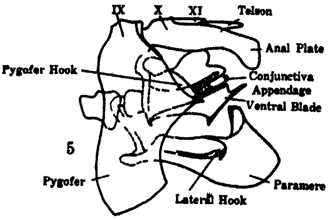

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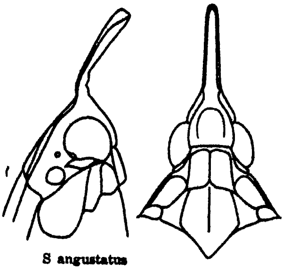
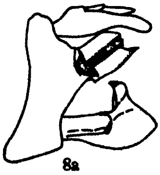


S angustatus

6



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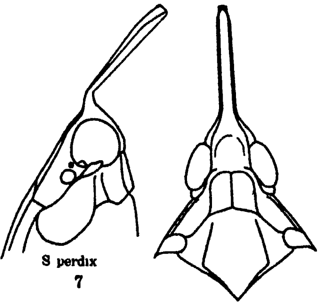
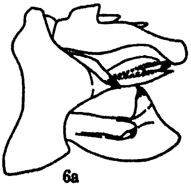


S perdix

7



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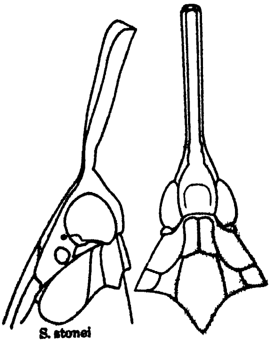
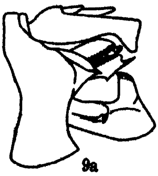


S. stonei

Holotype

8



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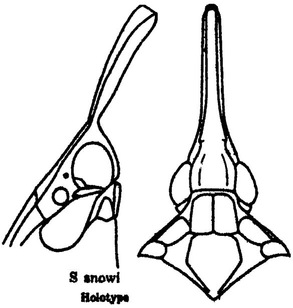


S snowi

Holotype

9

PLATE LXIV.

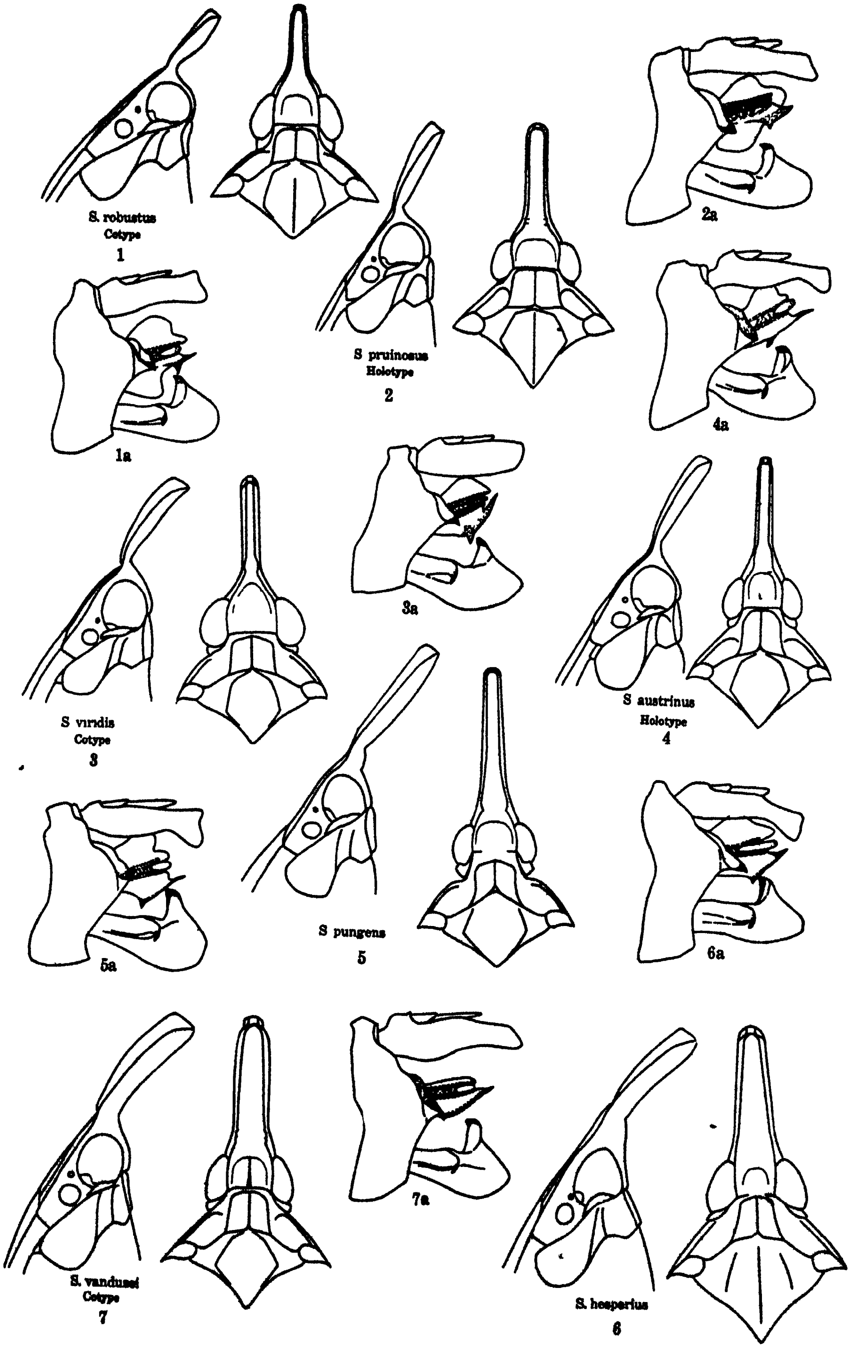

S. robustus
Cotype
1
2a
1a
S pruinosus
Holotype
2
4a
3a
S viridis
Cotype
3
S austrinus
Holotype
4
5a
S pungens
5
6a
7a
S. vandusei
Cotype
7
S. hesperius
6

PLATE LXV.

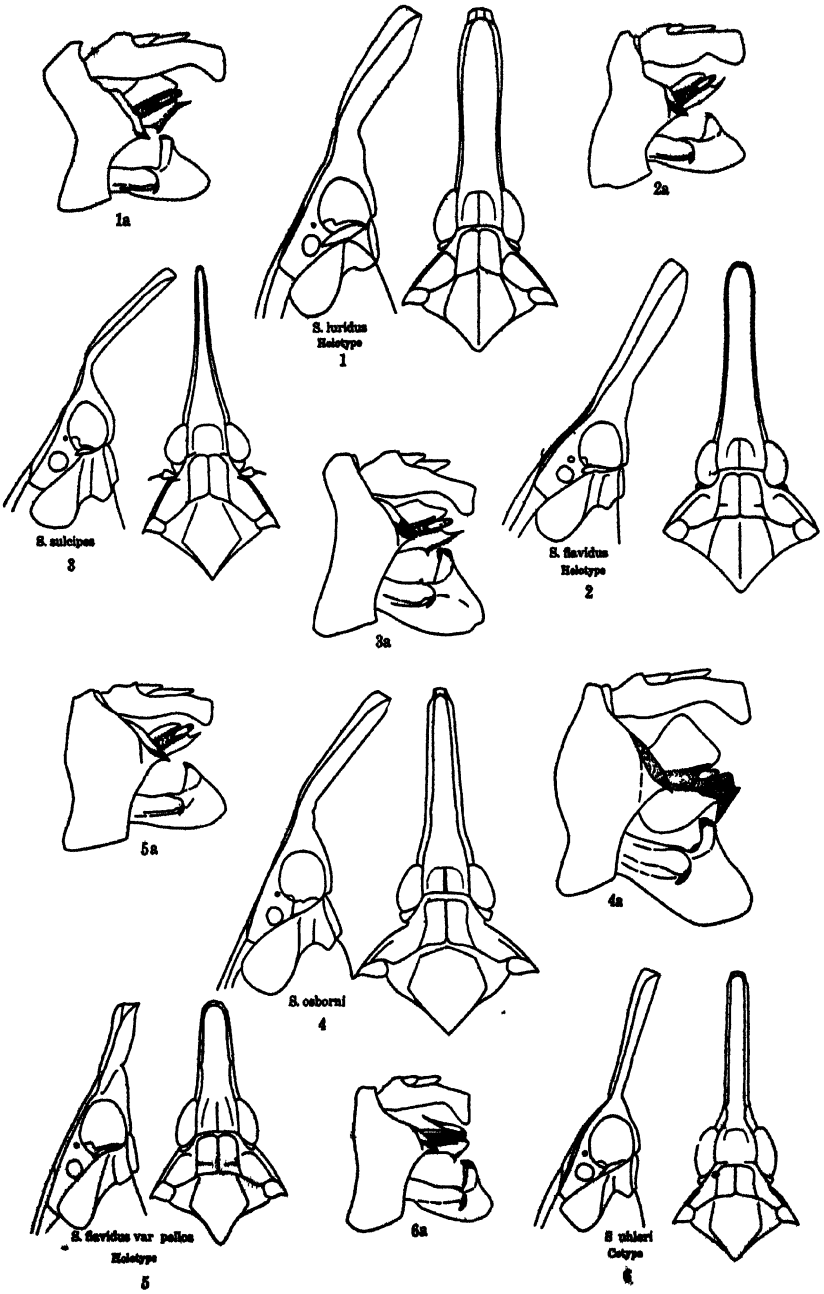
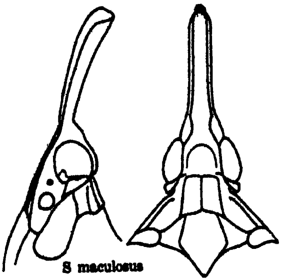

1a
S. luridus
Holotype
1
2a
S. sulcipes
3
3a
S. flavidus
Holotype
2
5a
S. osborni
4
4a
S. flavidus var pallos
Holotype
5
6a
S uhleri
Cotype
6

PLATE LXVI.



S maculosus
Cotype
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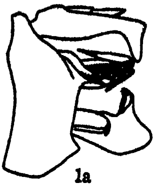

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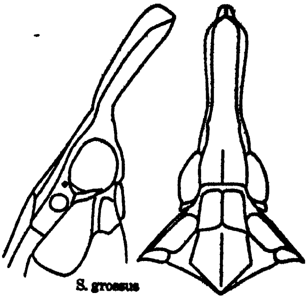

S. grossus
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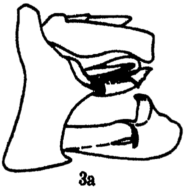

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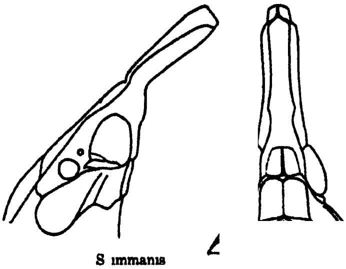
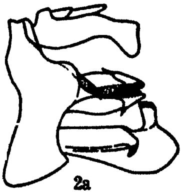


S immanis
Holotype
3



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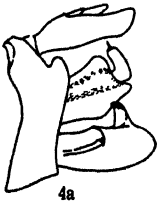

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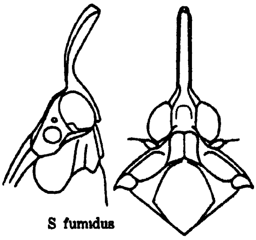

S fumidus
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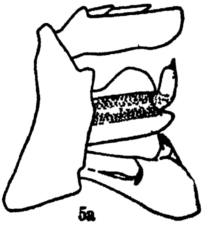

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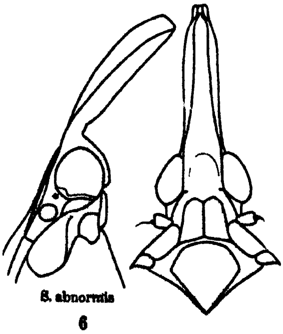

S. abnormis
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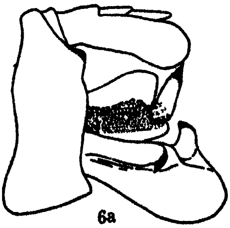

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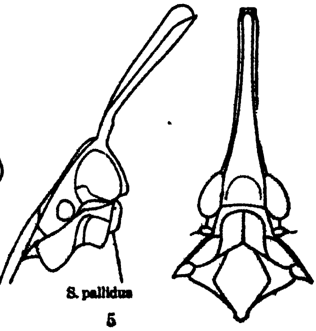

S. pallidus
5

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

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Study of the Life History and Spotting Habits of *Eutettix chenopodii* (Homoptera, Cicadellidæ).*

ISETTA PEARL CARPENTER, Department of Entomology.

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INTRODUCTION.

HISTORICAL SKETCH.

OSBORN (1), in 1887, was the first to associate the characteristic spotting on *Chenopodium album* with the leaf hopper, *Eutettix strobi* Fitch. He considered the reddish injury on the plant a natural protection to the reddish nymphs of this species. Brunner (2), in 1891, stated that this species was "very partial" to *Chenopodium album* and described its injury. Forbes and Hart (3), noted that " it causes the dark purple spotting often seen on the leaves of lamb's-quarter, and probably a similar discoloration common on beet leaves." Ball (4), in 1907, stated that the nymphs live on lamb's-quarter, where their punctures cause purple spots on the leaves. He found there were two broods in a season, adults appearing in June and again in August. Fenton (5), in 1924, described the injury as a series of distinct crimson-colored spots more or less circular in outline, the tissue of the leaf being convex in the discolored area. Spotting was found to be more distinct on the lower side where the areas were concave. The spots were located at any point on the leaf that might become confluent. The margin of the affected leaves curled under and the plants became stunted and dwarfed. His attempts to rear a third generation in 1920 failed. Lawson (6), in 1920, reported this species producing purple spots on *Chenopodium* in a widely distributed area in the state of Kansas,

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* Submitted to the Department of Entomology and the faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

METHODS OF STUDY.

This study on the life history and spotting habits of *Eutettix chenopodii* Osborn, formerly called *Eutettix strobi* (Fitch), extended from May 28 to September 15, 1926. Both adults and nymphs of the first generation were observed in the vicinity of the University of Kansas, chiefly on lamb's-quarter (*Chenopodium album* L.), which grew abundantly along the Kansas river.

Observations were made from specimens collected and reared on various plants in the insectary. Daily records were kept, and in some instances two or three observations were made within a twenty-four hour period.

Lamb's-quarter, pigweed (*Amaranthus hybridus* and *A. blitoides*) and purslane plants (*Portulaca oleracea*) were secured from localities free from *Eutettix chenopodii*. All other plants used were grown from seed.

An attempt was made to rear *Scaphoideus* nymphs found on the same plants and under the same conditions as *Eutettix chenopodii*, but these all proved unsuccessful. Evidently these nymphs, while living sometimes on the same hosts, obtain their food from other plants, as all that were started in the insectary died within a few days.

In the study of the injury produced on the leaves of the host plants, the greatest of care was exerted in order to avoid any possible infestation of healthy plants from infected ones. Controls were run along with each host plant used, and in no case did these reveal spotting or signs of curling.

LIFE HISTORY NOTES.

DESCRIPTION OF SPECIES.

Dr. P. B. Lawson, in his paper on the Cicadellidæ of Kansas, gives the following description of this species:

"Form: Length, 4.5 to 5.25 mm. Vertex one-fourth longer on middle than next the eye, two and one-half times as wide as long, with a faint transverse depression, and broadly rounded apically. Pronotum over twice as wide as long, lateral margins rather short. Elytra moderately long.

"Color: Vertex, pronotum and scutellum varying from yellowish irrorate with brown to reddish brown. Elytra usually milky white with bands of brown at base, and across apical half of clavus. Frequently these bands are so run together as to give the entire elytra a brownish appearance. Face the color of the vertex.

"External genitalia: Female, last ventral segment long, lateral angle broadly rounding, posterior margin notched on either side of a small median notched lobe which gives the appearance of two median teeth; pygofers broad, nearly or quite equalling the ovipositor, sparsely spined. Male, valve broad, rounded posteriorly; plates broad basally, then rapidly narrowed, ending in elongate filamentous tips which exceed the pygofers.

"Internal male genitalia: Styles large, triangular, broad basally, terminal process slightly convex on mesal margin, posteriorly straight on outer margin; connective very stout, Y-shaped, arms about equalling the basally broadened stem; œdagus with a wide, dorsal process to anal tube membrane, terminal portion composed of a broad median straplike and terminally bifid process and a pair of lateral narrower and acutely pointed processes."

DISTRIBUTION.

Specimens have been examined from Massachusetts, Connecticut (Britton), New York (Van Duzee), Niagara, Canada (Osborn), Pennsylvania (Wirtner), Ohio (Osborn), Iowa (Osborn, Ball), Missouri (Heid. coll., Osborn coll.), Nebraska (Bruner), Kansas (Snow, Crev.), Colorado (Gill., Ball), Utah (Ball), Texas (College Station, Sanderson; Victoria, U. S., N. M.)

Chenopodium album is a native of Europe and is introduced everywhere in this country. Undoubtedly the distribution of this insect is limited only by the range of this plant.

This species is one of the most widely distributed of the leaf hoppers in Kansas. Dr. P. B. Lawson has noted them in eighteen counties across the state. The writer has observed many of them, also, in two more counties, Wyandotte and Leavenworth.

HOSTS.

This species may be found on a number of hosts. Lamb's-quarter (*Chenopodium album*) is its normal host, but it will live and produce the same results on beet (*Beta vulgaris*), and chard (*Beta vulgaris*, var. *cicla*) and pigweed (*Amaranthus hybridus* and *A. blitoides*). In the field, nymphs have also been observed spotting purslane (*Portulaca oleracea*) and wormseed (*Chenopodium ambrosioides* var. *anthelminticum*). In the insectary, the insect was reared on all the above plants except the wormseed Observations in the field revealed the characteristic markings also on another pigweed (*Amaranthus retroflexus*) and peppergrass (*Lepidium virginicum*).

HIBERNATION.

Nymphs in the third, fourth and fifth instars were observed in the field as late as September 15. In all probability, all of those that emerged as adults were the ones to overwinter. It is thought they overwinter under grass and leaves on the ground.

MATING AND OVIPOSITION.

In producing a third generation, seventy-six pairs of mated adults were caged on the various host plants (charts 1-5) The period of copulation varied from forty minutes to two hours and forty minutes. One pair of adults was observed to mate within a few hours of their emergence into the adult stage Adults mated but once Ovipositing was watched both in the field and in the insectary and the following observations made:

CHART I.—Mated adults on beet (*Beta vulgaris*)

Cage No.	Emergence of adults.	Placed in cage	Mating	First appearance and number of eggs.	First hatching and number of eggs hatched.	Preoviposition	Total number of eggs hatched	Condition of plant	History of mating adults.
1	7-16-26	7-16-26		7-19-26 1	7-28-26 1	3	12	1 leaf curling where egg had been placed 7-17-26 3 spots on 1 leaf 8-8	Male dead 7-19 Female dead 8-7
2	7-16	7-16		7-23 3		7		Leaves containing eggs all eaten on edges where eggs were 9-14	Male dead 7-17 Female escaped
3	7-16	7-16		7-23 13	7-28 12	7	25	1 leaf curled 7-17 1 leaf dead 7-29 2 leaves dead 8-4	1 adult partly eaten by pill bugs 7-27 1 adult missing 7-29
4	7-16	7-16		8-1 2		16		Leaves containing eggs eaten 9-14	Male dead 7-20 Female placed in cage to hibernate 8-13
5	7-16	7-16		7-19 4	7-29 2	3	43	1 spot in large leaf 8-2 1 spot in large leaf 8-12	Adults placed on beet 7-31
6	7-17	7-17	7-19 10 20 a m	7-22 5	8-1 3	5	8	1 leaf dried 7-26 1 leaf dried and curling 7-27 1 leaf dried and yellow 7-28 1 spot in 1 leaf 8-2 Plant dead 8-11	1 adult missing 7-31 1 adult placed in cage to hibernate 8-11
7	7-29	7-29						Only one leaf left on plant 8-7 Plant almost dead 8-13	Female dead 8-5 Male dead 8-9

CHART I.—Mated adults on beet—CONTINUED

Cage No.	Emergence of adults	Placed in cage	Mating	First appearance and number of eggs	First hatching and number of eggs hatched	Preoviposition	Total number of eggs hatched.	Condition of plant	History of mating adults.
8	7-29 Reared from second generation on lamb's-quarter 4	7-29						2 leaves dead 8-1 Given new plant 8-3 Second plant dead 8-8	Female dead 8-1 Male dead 8-4
9	7-29 Reared from second generation on lamb's-quarter 4	7-29		8-3 5		5	2	1 small leaf half eaten 8-13 1 leaf dried up and 4 spotted by nymphs 9-17	Adults placed in cage to hibernate 9-17
10	7-29 Reared from second generation on lamb's-quarter 13	7 29		8-4 2	8-12 1	6	19	3 leaves 7 8 spotted by the nymphs left on 9-17	Adults dead 9-17
11	7-29 Reared from second generation on lamb's-quarter 13	7-29		8-9 10		11		1 leaf dead 8-4. Eggs in leaves eaten 9-17	1 adult escaped 9-17 1 adult dead 9-17
12	8-3 Reared from second generation on lamb's-quarter 13	8 3	8-5 9 40 a m	8-9 13		6	23	Leaves quite spotted by nymphs and turning yellow some dead 9-17	Adults dead 9-17
13	8-3 Reared from second generation on lamb's-quarter 4	8-3						Plant alive 9-17	Adults dead 9-17
14	8-7 Reared from second generation on lamb's-quarter 4.	8-7						Plant dying 9-17	Adults dead 9-17

CHART I.—Mated adults on beet—CONCLUDED.

Cage No.	Emergence of adults.	Placed in cage.	Mating.	First appearance and number of eggs.	First hatching and number of eggs hatched.	Preoviposition.	Total number of eggs hatched.	Condition of plant.	History of mating adults.
15	7-31 From beet, 5.	7-31		8-3 6 or 8		3		Plant dying 8-5. Plant dead 8-9.	Adults dead 8-6.
16	7-26 2 Mating pair.	7-26							Female dead 7-31. Male missing 8-12. Female dead 8-13. Male placed in cage to hibernate 8-13.
17	7-26 2 Mating pair.	7-26		8-3 (few)		8	5	1 lower leaf dying 8-4. 1 leaf dying 8-5. Given new plant 8-6.	Female dead 7-28. Male dead 8-9. 1 adult dead 9-14. 1 adult placed in cage to hibernate 9-14.
18	7-31 2 Males and 1 female.	7-31							Male missing 8-11. Male and female placed in cage to hibernate 8-13.
19	8-9 Pair from pigweed, 2.	8-9		8-12 (few)		3			Adults placed in cage to hibernate 8-13.

CHART II —Mated adults on chard (*Beta vulgaris* var *Cicla*)

Cage No.	Emergence of adults.	Placed in cage.	Mating	First appearance and number of eggs	First hatching and number of eggs hatched	Preoviposition	Total number of eggs hatched	Condition of plant	History of mating adults.
1	7-16	7 16		7-22 2 7-30 12 (On third plant)	8-10 4	6 14	7	Plant dead given new plant 7-20 Second plant dead with eggs eaten 8 1 All other leaves with eggs eaten 8-13	Female dead 8-5 Male dead 8-12
2	7-16	7-16						Plant dried given new plant 7-20 Plant dead 7 29	1 adult dead 7-23 1 adult escaped 7-24.
3	7-16	7-16	7-18 6 30 p m	7-21 10 or 12	8-1 1	5	25	Edges of several leaves eaten by pill bugs 7-30 Several more eaten 8-1 Plant healthy 8-13	Adults placed on chard 15, 8-1
4	7-16	7-16		8-11 Several		26		4 leaves dead 7-29 Stem eaten 8-3 Plant broken 8-13	Male dead 7-23 Female placed in cage to hibernate 8-13
5	7-16	7-16						Plant healthy 8-13	Male escaped 7-24. Female placed in cage to hibernate 8-13
6	7-16	7-16						Plant rotted at ground 7-19	Female dead 7-17 Male dead 7-19
7	Male 7-21 Female 7-22	7-22						Plant healthy	Adults placed in cage to hibernate 7-18

CHART II.—Mated adults on chard—CONCLUDED

Cage No.	Emergence of adults.	Placed in cage.	Mating	First appearance and number of eggs	First hatching and number of eggs hatched	Preoviposition	Total number of eggs hatched.	Condition of plant	History of mating adults.
8	7-21	7-22	7-23 8 30 a m.	7-28 12				1 leaf dried 7-30 Plant drying 7-31 Plant dead 8-2	Adults placed on chard 14.
9	7-22	7-22		7-30 3	8-10 3	8	8	Leaves with eggs eaten 8-13	Female missing 8-22 Male placed in cage to hibernate 8-13
10	7-29	7-29		8-2 2	8-11 1	4	3	Leaves badly eaten by pill bugs 8-13 Leaves with eggs eaten 8-4.	Male missing 8-11 Female placed in cage to hibernate 8-13
11	7-29	7-29						Plant dying 8-4 Plant dead 8-13	Male missing 8-12. Female placed in cage to hibernate 8-13
12	7-29	7-29						Plant healthy 8-13	Male missing 8-2 Female placed in cage to hibernate 8-13
13	7-23 2 pair	7-23	7-29 9 05 a. m. till 9 45 a. m.	7-30 (few)	8-9 1	7	23	1 leaf 18 spots large 1 leaf 69 spots and 5 large areas that are red 1 leaf 93-100 spots These made by nymphs left on plant 9-14	Male partly eaten 8-5 Female escaped 8-9 Male eaten 8-12 Female placed in cage to hibernate 8-13
14	7-31 From chard 8	7-31 From chard 8		8-4 (few)	8-13 1	10 (?)	1	Leaves eaten 8-10 Leaf with many eggs eaten 8-12	1 adult dead 8-12 1 adult escaped 8-12.
15	8-1	From chard 3		8-6 (few)	8-13 2	5?	2	Plant healthy	Adults placed in cage to hibernate 8-13

CHART III.—Mated adults on lamb's-quarter (*Chenopodium album*).

Cage No	Emergence of adults	Placed in cage	Mating	First appearance and number of eggs.	First hatching and number of eggs hatched	Preoviposition	Total number of eggs hatched	Condition of plant	History of mating adults.
1	7-16	7-16		7-21 4	7-30 3	5	23	Plant healthy 8-13	1 adult missing 7-31 1 adult dead 7-26.
2	7-16	7-16						Few leaves dropped off 8-3	Male dead 7-17 Female escaped 7-22
3	7-16							1 leaf eaten 7-30	Male dead 7-28 Female escaped 7-31
4	Male 7-16 Female 7-17	7-17		7-26 3	7-30 1	9	1	Plant healthy 8-13	Both escaped 7-23
5	Male 7-16 Female 7-17	7-17		7-26 3	7-30 1	9	1	Plant healthy 8-13	Both dead 7-21.
6	7-20	7-21				13		Plant healthy 8-13 No change in plant 9-14.	Male dead 7-30 Female dead 8-13
7	7-20	7-21						White spots on leaves 7-30 Plant healthy 8-13	1 adult dead 7-28 1 adult dead 7-29
8	7-31 From second generation on lamb's-quarter, 4	7-31						Plant healthy 8-13	Adults dead 8-4
9	7-31 From second generation on lamb's-quarter 13	7-31						Plant healthy 8-13	Female dead 8-5 Male dead 8-11

CHART III.—Mated adults on lamb's-quarter—CONCLUDED.

Cage No.	Emergence of adults.	Placed in cage.	Mating.	First appearance and number of eggs.	First hatching and number of eggs hatched.	Preoviposition.	Total number of eggs hatched.	Condition of plant.	History of mating adults.
10	7-31 .... Lamb's-quarter 13, same as (9).	7-31	. ...	8-13 (?)	.....	 13	 14	Plant much spotted and turning yellow 9-17.	Adults dead 9-17.
11	7-29 .. .. 2 females and 1 male from lamb's-quarter 4, second generation	7-29	. .	. . ..		. .	. ...	Plant healthy 8-13.	Female dead 8-1. Male missing 8-4. Female dead 8-8.
12	1 male and 1 female 7-20.. ... 1 female 7-21	7-21	....	......	....	... .	....	Plant healthy 8-13.	1 dead 7-25. 1 dead 7-26. 1 dead 7-27.
13	1 male and 1 female 7-22...... 1 female 7-21	7-22	....	.. ....	......	....	....	Yellow spots in few leaves 7-30.	Male dead 7-25. Female dead 7-30. Female missing 8-4.
14	7-26......... . . . 3 females and 1 male	7-26	. ...	7-29 5	. . ...	 7	....	2 lower leaves yellow 8-12. Plant alive 9-17.	1 adult missing 7-31. 1 adult dead 9-14. 2 adults placed in cage to hibernate 9-14.
15	8-6 . . .. From pigweed, 7.	8-6	..... .	. ... .	.. ..	......	. ...	Plant healthy 8-13.	Adults eaten 8-11.
16	7-23 . .. . 2 pair.	7-23	8-10 9:53 a. m.	8-1 (few)	. .	 14	. ...	Leaf at bottom dried 7-27. Leaf at bottom dead 7-29. Plant dead 9-14.	Adults placed in cage to hibernate 8-13.
17	8-8 .... From pigweed, 5.	8-8	. .....	... .	....	.. . .	....	Plant healthy 8-13.	Male dead 8-10. Female dead 8-11.

CHART IV.—Mated adults on pigweed (*Amaranthus hybridus*)

Cage No	Emergence of adults	Placed in cage	Mating	First appearance and number of eggs	First hatching and number of eggs hatched	Preoviposition	Total number of eggs hatched	Condition of plant	History of mating adults.
1	7-13	7-13	7-13 10 40 a m. to 1 20 p m.	7-16 8	7-25 3	12	8	Leaves falling 7-28 All leaves gone from plant 8-2	Male dead 7-16 Female dead 7-19
2	7-20	7-20		7-30 6	8-9 3	9	17	Plant healthy	Adults placed on beet, 12, 8-9
3	7-19	7-19						Holes in lower leaves 7-30	Female dead 8-1 Male dead 8-11
4	7-19	7-19						2 leaves eaten 7-23 Holes in leaves 7-26.	Male dead 7-23 Female missing 7-23.
5	Male 7-21 Female 7 20	7-21		7-30 2 or 3	8-10 1	8	1	Leaves eaten on edge 7-30 1 leaf dropped off 7-31 1 leaf with eggs eaten 8-8. Plant dried entirely 9-17	Adults placed on Pursley, 7, and died 8-10
6	7-21	7-21		7 26 5	8-6 2	5	29	1 leaf turning yellow 7-30 Leaves eaten on edge 8-2	Adults placed in lamb's-quarter, 12, 8-6.
7	Male 7-21 Female 7-20	7-21		7-29 4	8 8 3	8	28	Several leaves eaten.	Male escaped 7-30 Female placed in cage to hibernate 8-13.

CHART IV —Mated adults on pigweed—CONCLUDED.

Cage No.	Emergence of adults	Placed in cage	Mating	First appearance and number of eggs	First hatching and number of eggs hatched.	Preoviposition.	Total number of eggs hatched.	Condition of plant	History of mating adults.
8	From second generation on lamb's-quarter, 13	8-3						Plant alive 9-17	Adults dead 9-17
9	7-21 1 male and 2 females	7-21		7-30 4 or 5	8-8 5	8	18	Edges of 4 leaves eaten 7-30 Leaves with eggs eaten 8-12	Female escaped. Male and female placed on lamb's-quarter, 13
10	7-31 2 pair	7-31		7-11 (few)		11		Plant healthy 8-13	Female dead 8-6 Male dead 8-10 2 adults partly eaten 8-10

CHART V —Mated adults on purslane (*Portulaca oleracea*)

Cage No	Emergence of adults	Placed in cage	Mating	First appearance and number of eggs	First hatching and number of eggs hatched.	Preoviposition	Total number of eggs hatched	Condition of plant	History of mating adults.
1	Male 7-16 Female 7-17	7-17						Brown spots in a few leaves 7-26. Plant healthy 8-13	Adult dead 7-20 Adult dead 7-22
2	Male 7-19 Female 7-18	7-19						Plant healthy 8-13	Both dead 7-20
3	Male 7-19 Female 7-18	7-19		7-23-26 12		4		Leaf with eggs broken from plant 8-2 Plant healthy 8-13	Boath dead 7-26
4	Male 7-20 Female 7-18	7-20						Plant healthy 8-13	Both dead 7-23
5	7-26	7-26						2 large leaves decayed 8-1 Plant dead 8-3	Both dead 7-31
6	7-28 2 pair	7-28						Plant healthy	Female missing 7-30 Male dead 7-30 Female dead 8-1 Male missing 8-6
7	Male lamb's-quarter 13 2 females lamb's-quarter 4 From second generation.	8-3						Plant healthy 8-13	Male and female dead 8-8 Female placed in cage to hibernate 8-13
8	7-28 2 pair	7-28						Several leaves 7-30	Male dead 7-30 Female dead 8-1. One missing 7-30 1 placed in cage to hibernate 8-13.
9	8-7 From pigweed. 5	8-7						Plant healthy 8-13	Adults dead 8-10

OBSERVATIONS ON EGG LAYING. The eggs are inserted in the tissues of the upper surface of the leaf, just under the epidermis. The female slowly creeps to the edge of the leaf and places her front pair of legs, one on one side of the leaf and the other on the opposite side just a short distance past the edge. After placing the beak on the edge of the leaf to brace herself firmly, the body is bent so as to bring the tip of the abdomen down, with the ovipositor just touching the surface of the leaf. The inner valves of the ovipositor are then unsheathed from the outer ones and by a sawing movement a small slit is made in the epidermis. By grasping the leaf more firmly with the hind legs, the ovipositor is inserted its whole length into the opening already made. The egg passes between the valves of the ovipositor into the small chamber made for it, and the ovipositor is withdrawn and again sheathed. She may repeat this process in a few seconds or may wait several hours.

POSITION OF THE EGGS. From 30 to 120 seconds are usually consumed in placing one egg. Most of this time is used in preparing the chamber. The eggs have no special arrangement. Sometimes they are in rows, but usually they are placed singly and irregularly, although they may touch each other at the ends. However, each egg is placed in a separate puncture. They may be placed anywhere on the flat surface of the leaf as well as near the edge. Observations on beet and chard revealed eggs and egg punctures quite numerously at the base and the petiole in preference to the leaf edge.

NUMBER OF EGGS. The largest number of eggs from one female adult was forty-three and the smallest number was one. Only twenty-six pairs of the mated adults produced eggs. The number of eggs in one leaf varied from one to eighteen according to the size of the leaf. The average number of eggs that hatched from twenty-four pairs of adults was fourteen. One hundred forty-six eggs were laid on beet leaves and forty on lamb's-quarter. Eggs were found on all of the hosts with the exception of purslane.

EFFECT OF OVIPOSITION ON THE LEAVES. Oviposition affects the leaves but slightly. The small punctures or egg chambers turn white or yellow, but otherwise the leaf grows naturally and appears normal, unless it is quite small and has very many punctures made in it.

PREOVIPOSITION PERIOD. From chart 6 the preoviposition period, the length of the egg stage, and the number of eggs hatched may be obtained.

CHART 6.—Showing the length by days of preoviposition period, length of egg stages and number of eggs hatched by mated adults of the third generation from July 16 to September 14, 1926

PLANT	Cage No of mated adults	Preoviposition period	Egg stage	Number of eggs hatched
Beet	1	3	9	12
	2	7		
	3	7	5	25
	4	16		
	5	3	10	43
	6	5	10	8
	9	5		4
	10	6	8	21
	11	11		
	12	6		27
	17	8		6
Total		77	42	146
Average		7	8 4	18 2
Chard	1	6	11	7
	3	5	11	25
	4	26		
	9	8	11	8
	10	4	9	3
	13	7	10	29
	14		9	1
	15		7	2
Total		56	68	75
Average		9 3	9	10 7
Purslane	3	7		
Total		7		
Average		7		
Lamb's quarter	1	5	9	23
	5	9	4	1
	6	13		
	10	13		16
	14	7		
	15	14		
Total		61	13	40
Average		10 1	6 5	13 3
Pigweed	1	12	9	8
	2	9	10	17
	5	8	11	1
	6	5	11	29
	7	8	10	28
	9	8	9	18
	10	11		
Total		61	60	101
Average		8 7	10	16 8
		31 pairs of mated adults	20 pairs of mated adults	24 pairs of mated adults
Summary				
Beet		7	8 4	18 2
Chard		9 3	9 7	10 7
Lamb's quarter		10 1	6 5	13 3
Pigweed		8 7	10	16 8
Purslane		7		
General average		8 4	8 6	14 7

From thirty-one mated adults the average length of the preoviposition period on all host plants was 8.4 days. The shortest period was three days, and the longest period twenty-six days. This period was the shortest on beet and the longest on lamb's quarter.

INCUBATION PERIOD. The time required for the incubation of the eggs in the same brood averaged 8.6 days for the eggs from twenty pairs of adults. The shortest incubation period was four days, the longest eleven days. Incubation was completed most quickly, averaging 6.5 days, on lamb's quarter. Ten days were required on pigweed.

EMERGENCE FROM THE EGG. From one to twelve minutes are consumed by the nymphs while emerging from the egg. The head appears first at the tiny opening in the epidermis of the leaf made when the egg was inserted. This is followed by part of the body which sways forward, backward, and sideways every few seconds with brief rest periods in between. Gradually more of the body appears. The first pair of legs are soon dried. As soon as the second pair becomes visible, the nymph widens the angle of swaying, continuing this motion until the first two pairs of legs rest on the surface of the leaf. After firmly securing a foothold, the rest of the body is pulled from the egg with several hard tugs. As soon as completely dry, which is only a few seconds, these small nymphs are able to hop about from one leaf to another. When walking about on a leaf, they frequently go sideways, somewhat similar to a crab.

NYMPHS.

LENGTH OF NYMPHAL LIFE. During their nymphal life, these leaf hoppers molted five times and became adults in thirty-one days in the second generation and thirty-four days in the third generation. Of the eleven individuals of the third generation becoming adults, the average nymphal period was but thirty-two days. (Chart 7.) In the second generation, the shortest nymphal stage observed was twenty days and the longest forty-six days, while in the third generation this stage varied from twenty-five to forty-four days. Chart 8 shows the records and average length of each instar, the tendency being for the life of the instar to lengthen progressively with the age of the nymph.

CHART 7 —Length of instars

No of generation	First instar			Second instar			Third instar		
	Longest	Shortest	Average	Longest	Shortest	Average	Longest	Shortest	Average.
Second	*7	*7	7	10	4	6–7	12	3	6 6
Third	18	2	5 8	15	2	5 5	12	2	6 5
Number of nymphs			111			78			52

* One nymph only

CHART 7 —CONCLUDED

No of generation	Fourth instar			Fifth instar			Nymphal period		
	Longest	Shortest	Average	Longest	Shortest	Average	Longest	Shortest	Average.
Second	9	3	5 4	8	3	5 5			31 2
Third	12	4	7 4	14	5	8 7	44	25	33 9
Number of nymphs			26			11			

CHART 8.—Length of instars of third generation.

Number.	1	2	3	4	5	Number.	1	2	3	4	5
1	5	*5				76	6	4	10	*16	
2	5	6	4	6	*3	77	5	5	*7		
3	*1					78	5	4	8	7	6
4	5	*1				79	6	4	8	*12	
5	*3					80	5	3	*8		
6	7	4	4	*9		81	5	*1			
7	*7					82	4	*6			
8	*5					83	6	4	*7		
9	*4					84	4	4	5	*3	
10	4	*4				85	5	3	*5		
11	4	6	3	*10		86	5	3	4		
12	5	*2				87	*6				
13	5	*1				88	4	5	*3		
14	4	5	3	*7		89	*2				
15	5	5	4	*9		90	5	*0			
16	6	6	3	6	*15	91	6	4	*4		
17	4	7	8	9	11	92	*4				
18	5	*2				93	7	6	6	6	14
19	7	*4				94	5	6	9	8	
20	5	4	4	4	*2	95	6	*8			
21	*4					96	5	4	9	10	
22	8	4	4	*8		97	7	*1			
23	*5					98	6	4	5	7	*7
24	8	5	*1			99	5	5	8		
25	*2					100	*1				
26	*4					101	6	3	12	*14	
27	7	4	3	*10		102	*1				
28	*5					103	8	*3			
29	*4					104	6	4	11	*11	
30	*4					105	5	6	12	12	*0
31	6	*1				106	6	2	*13		
32	*4					107	5	5	7	10	*14
33						108	7	*0			
34	*3					109	5	5	*3		
35	*3					110	4	*7			
36	*3					111	5	7	5	6	9
37	6	3	4	*3		112	5	9	6	6	*3
38	*3					113	4	4	7	5	5
39	*3					114	6	7	10	*10	
40	*3					115	*3				
41	*3					116	5	*14			
42	*3					117	5	*8			
43	7	4	6	*4		118	6	8	7	*0	
44	*2					119	*2				
45	6	4	3	8	*5	120	4	6	5	6	6
46	6	4	*5			121	5	*7			
47	7	5	2	*2		122	*3				
48	*1					123	5	10			
49	*2					124	5	9	6	10	*1
50	*2					125	5	*3			
51	8	3	*8			126	*11				
52	*5					127	*2				
53	7	4	*1			128	*2				
54	6	3	*7			129	*3				
55	*1					130	*2				
56	*1					131	5	6	*6		
57	*1					132	*2				
58	*1					133	5	*3			
59	5	3	5	*1		134	*7				
60	4	3	6	7	*9	135	*4				
61	5	3	*5			136	5	*4			
62	5	*3				137	12	7	4	*10	
63	7	5	10	8	14	138	13	*2			
64	7	5	*1			139	9	11	11	*2	
65	*2					140	5	10	*6		
66	4	4	3	*14		141	*2				
67	5	3	*5			142	5	*0			
68	5	4	6	6	7	143	*3				
69	5	3	*3			144	*2				
70	4	4	5	*1		145	5	10	*0		
71	*5					146	*7				
72	5	3	9	9	*12	147	*4				
73	6	6	*3			148	7	*2			
74	5	3	7	*2		149	5	*1			
75	4	3	*9			150	*3				

CHART 8.—Length of instars of third generation—CONCLUDED.

Number.	1	2	3	4	5	Number.	1	2	3	4	5
151	*4					176	*6				
152	8	6	8	9	*2	177	*7				
153	*2					178	6	6	6	6	8
154	9	15	*9			179	*5				
155	5	12	12	*1		180	*4				
156	*2					181	*9				
157	10	4	5	6	9	182	6	*1			
158	*4					183	*7				
159	*1					184	*2				
160	8	*1				185	*4				
161	*1					186	*1				
162	*3					187	6	6	7	8	*3
163	*3					188	*4				
164	*5					189	*7				
165	*4					190	*5				
166	*5					191	*5				
167	*3					192	18	*1			
168	5	13	*2			193	*1				
169	9	11	5	*2		194	*4				
170	*4					195	3	*1			
171	*5					196	2	9	12	*4	
172	*3					197	*2				
173	*2					198	9	10	8	*4	
174	*2					199	9	*5			
175	6	11	7	7	*1	200	*8				

* Starred numbers indicate time of death.

DESCRIPTION OF THE NYMPHS. The first nymphs were a deep red color when fully developed and expanded, with small white markings and many white dots covering the body. As they grew larger and older, they became lighter in color, some of the fifth instars being almost pink. The terminal abdominal segment was usually pink in all instars. The red eyes and almost transparent legs and antennæ were constant throughout the nymphal life.

The first three instars bore metathoracic setæ. The first instar showed setæ on the last two abdominal segments only, the second instar showing them on seven segments of the abdomen, and the third instar showing not only the abdominal setæ but also the enlarged mesothoracic wing pads.

The fourth and fifth instars did not have metathoracic setæ, but did show the abdominal spines. In the fourth instar both the mesothoracic and metathoracic wing pads were apparent. In the fifth instar the wing pads extended to the fourth abdominal segment.

DESCRIPTION OF EGG AND NYMPHAL INSTARS.

Average individuals were selected for the descriptions of the various instars.

EGG. Length, 1 mm.; width, 0.25 mm. Elongate and slightly curved, the anterior end being somewhat less rounded. Color, light yellow, almost white at first; just before hatching becoming a deeper yellow; eye spots distinct two to three days before hatching.

FIRST INSTAR. Length, 1 mm.; width, 1.25 mm. Antennæ 2.25 mm., elongate white. Two metathoracic spines and four spines on each of last two abdominal segments white. Color, deep reddish purple, with many small white spots; eyes, brick red.

SECOND INSTAR. Length, 1.5 mm.; width, 15 mm. Four spines on last seven abdominal segments, two near the middle line, two following the lateral line. Mesothoracic wing pads evident; body long and narrow. Color, brick red, with increase of white spots, usually a narrow white band down middorsal line; last abdominal segment pale pink.

THIRD INSTAR. Length, 2.5 mm.; width, 0.75 mm. Abdominal spines present; mesothoracic wing pads covering first abdominal segment. Color, similar to second instar with enlargement of white spots; caudal edge of each abdominal segment showing white band.

FOURTH INSTAR. Length, 3 mm.; width, 1.25 mm. Metathoracic spines absent. Spines present on second and third pair of legs; abdominal segments with spines; mesothoracic and metathoracic wing pads covering first two abdominal segments. Color, abdomen darker red than third instar; thorax, pink.

FIFTH INSTAR. Length, 4 mm.; width, 1.5 mm. Metathoracic spines absent. Wing pads extending to fourth abdominal segment. Color, dorsally pale pink, becoming darker caudally on lateral portions of first five abdominal segments; wing pads white. Ventrally thorax darker than abdomen, latter in the first three segments white, last three pale pink.

ADULTS.

Male, length 4.5 mm.; width, 1.5 mm. Female, length 4.9 mm.; width 1.4 mm. The sexes cannot only be distinguished one from the other by their size, but also by their color. Both adults are typically brownish white in appearance, but the male shows the darker color of the two. Both the face and the vertex are of a pale yellow color.

NUMBER OF BROODS. There are three broods in a season. (Chart 9.) The nymphs of the first generation appear in early April. Adults of this generation were found in the field the first of June. From these, two more generations were reared in the insectary, the adults of the second generation appearing the middle of July and of the third generation the middle of August. The adults of the third generation were placed in hibernating cages in the early part of September.

Adults were never observed mating more than once. They were long-lived, one adult living from the middle of June until the middle of August. Both the nymphs and adults are found on the underside of the leaves, sometimes three or four on one leaf. Molting occurs also on the underside of the leaves where the molted skins are attached firmly. Plants growing in the direct sunlight are more apt to be infested than those in the shade.

CHART 9.—Showing the time of year in which eggs nymphs and adults of each generation appear

Number of generation	Eggs	Nymphs	Adults
First	April 5 to April 15	April 11 to May 31	May 31 to June 10
Second	June 10 to June 20	June 20 to July 15	July 15
Third	July 16 to July 26	July 26 to September 2	September 2

STUDIES IN SPOTTING.

CHARACTER OF SPOTTING.

The puncture of *Eutettix chenopodii* on *Chenopodium album* and the other host plants produces crimson-colored spots. These are usually round in outline, especially when first made. They soon become wrinkled and raised; that is, the leaf tissue from above grows convex and from below concave. On the under surface of the leaf the color is somewhat lighter.

LOCATION OF SPOTS ON LEAVES. The spots may occur anywhere on the surface of the leaf depending upon the feeding of the nymph. They do not follow the venation of the leaf, and very pretty patterns are sometimes made by the nymphs as they gradually move in circles or lines across the surface.

Often the spots run together and cover a large part or even all of a leaf, both small and large ones often becoming entirely red This is quite characteristic on pigweed and small *Chenopodium album* plants.

CURLING OF LEAVES. The margin of the affected leaves usually curls under and sometimes the whole leaf rolls up. Unless the plant is vigorous before becoming infected, it will be stunted. On young plants in the insectary, curling and stunting is very noticeable, and a number of the plants die from this cause. The time elapsing on chard leaves between the first curling and the final rolling up of the leaf is eight days. Curling of leaves is followed by the gradual loss of the green color and the death of the leaf.

Stems of plants were sometimes affected, especially at the nodes.

Nymphs kept in vials were given fresh lamb's-quarter or pigweed daily. Spots were discernible the following day, although they were sometimes faint. Nymphs reared on entire plants made spots that were easily visible the following day. Faintness of the coloring in the first instance was due probably to the fact that the leaves were drying out in the vials. If many spots appeared on one leaf, at a time, they usually were small and about the size of a pin point.

LIFE HISTORY AND SPOTTING.

An attempt was made to discover the effect upon the leaves by the various instars. Each nymph as soon as hatched was placed in a small vial with a cotton stopper. Daily observations were made of the nature and the number of spots. Fresh leaves were fed the nymphs daily, also. All nymphs reaching the fifth instar were caged on potted plants to allow more freedom.

Two hundred individuals were started. From chart 10 it was found that from 111 individuals living through the first instar, 30 spotted the leaves with an average of 6.7 spots for each individual. In 5 cases the spots developed during the first twenty-four hours after being fed upon by the insect. It is of interest to note that 8 individuals lived through the first instar without producing any spots, although they were often noticed feeding.

Seventy-eight individuals lived through the second instar, with 47 of them spotting the leaf, an average of 12.6 spots to each. Again 5 individuals spotted the leaves during the first twenty-four hours of incubation, while 31 failed to produce any spots at all.

The average number of spots per individual produced in the third instar was increased to 24.4 each, with 39 out of 52 individuals spotting, and 13 apparently having no effect upon the leaves.

A decrease in the average number of spots by each individual was discovered in the fourth instar, the average being only 21.1 spots in each individual. This may be explained by the fact that all of the nymphs that spotted failed to live through the instar, 31 spotting and but 26 living through this instar. Eight nymphs spotted leaves during the first twenty-four hours.

An increase developed during the fifth instar, even though more individuals produced spotting than lived through the instar, the numbers being 17 to 11. However, these averaged 64.1 spots to each nymph, with five spotting the leaf during the first twenty-four hours.

From these observations, it is evident that the ability to spot the leaves increases with the age of the nymph. Also the per cent of individuals causing injury and living through each instar increased with the age of the instar.

ADULTS AND SPOTTING.

One adult was caged on a beet plant from the first of June until the middle of August without spotting. Forty-six mated pairs of adults on beet, chard, lamb's-quarter and purslane for from four to eight weeks failed to show any spots. This would prove that the injury results from the nymphal stages entirely.

CHART 10.—Summary of spots made during each instar.

Number.	1	2	3	4	5
1	18				
2		1			
4	2				
6	1			8	
11		21			
12	7				
14		16		11	
15		*44		6	
16	3	8		*53	3
17		9	9		
20					2
22	5			15	
24	7				
27	6			20	
31	6				
37	18				
43	15		5		
45	28			24	
46	4		2		
47	1		33		
51	7		*40		
54			12		
60	4		35	5	17
61	4				
62	1				
63			19	28	1
64		7			
66	20			4	
68			20	30	*120
69			2		
70			12		
72				17	29
74			22		
75	1		8		
76			8		
77			25		
78				8	97
79				2	
80	1				
83			3		
84			9	3	
86	1				
91			16		
92		19		28	
93		19		28	3
94		1	4	25	2
95		8			
96			20	32	
98		7	19	*44	*261
99		1			
101		13	19		
103		1			
104		7	23	1	
105		10	13		
106		7	*60		
107			10	22	
110		1			
111		26	*58	*80	*77
112		6	16	21	
113		11	39	26	4
114		8	211		
116		3			
117		1			
118		14	9		
120		6	2	10	*221
121		7			
123		30			
124		13	10	15	
125		11			
131		20			
134	2				
137		16	*57	1	
138	4				
139	14	17	5		
140		21	1		
143		4			
148	6				
152		5			
154		8			
157	8	37	*74	*41	*125
168		13			
169		1			1
175		36			
177	2				
178		18	3	31	*95
187		27	24	16	23
192	5				
196		6			
198		22			
199	2	7			
Totals....	†	†	†	†	†

* Where many spots appeared. † See Chart 11.

CHART 11.—Summary of spots made during each instar.

	First instar.	Second instar.	Third instar.	Fourth instar.	Fifth instar.
Total number of spots in each instar	203	594	952	655	*1091
Total number of individuals spotting in each instar	30	47	39	31	17
Average number of spots made by each individual ..	6.7	12.6	24.4	21.1	64.1
Total number of individuals living through each instar,	111	78	52	26	11
Percent of individuals living through each instar that spotted	27.02	60.2	75	100	100

* Where many spots appeared.

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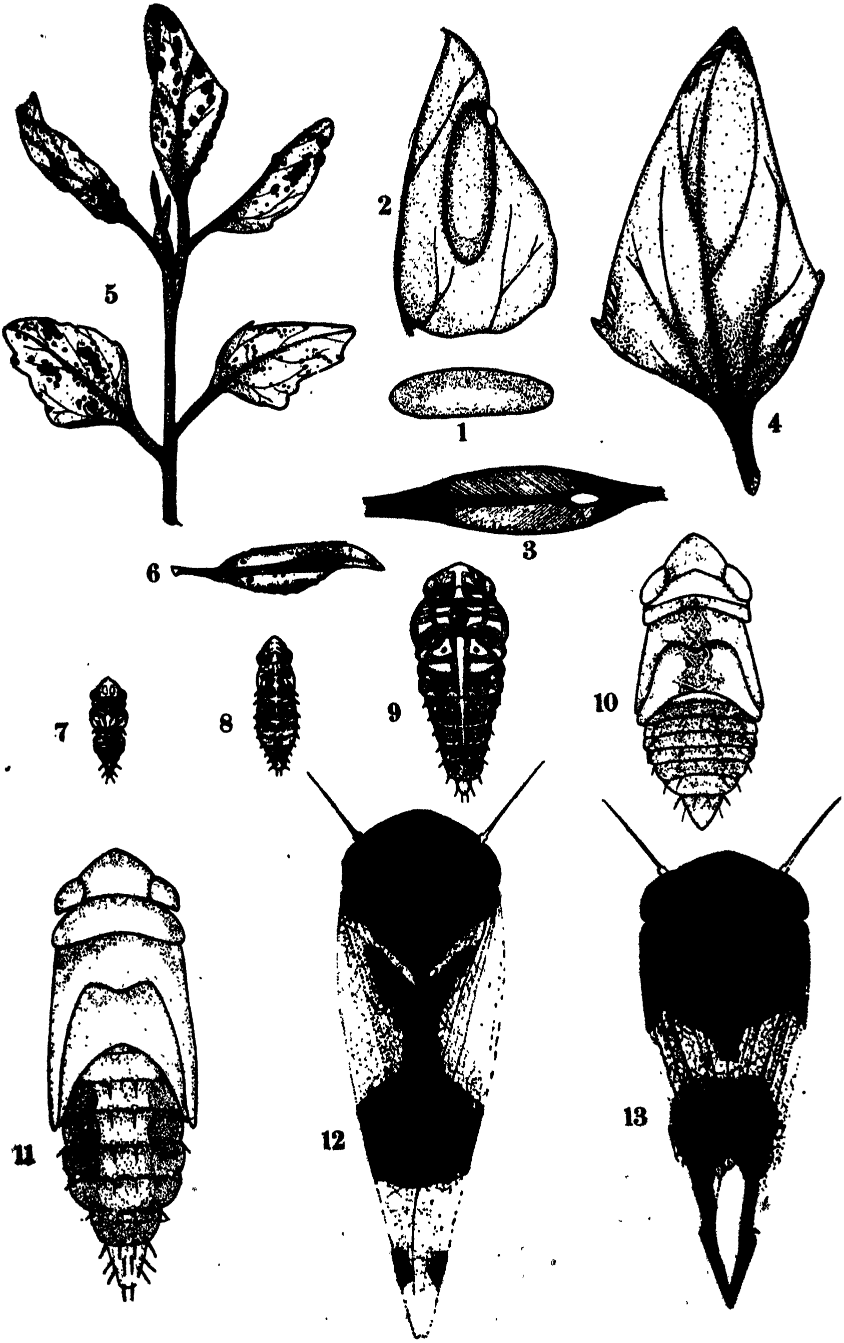
EXPLANATION OF PLATES.

PLATE LXVII

FIG. 1. Egg.
FIG. 2. Top of leaf showing position of egg.
FIG. 3. Edge of leaf showing position of egg.
FIG. 4. Leaf showing twelve eggs.
FIG 5. Upper part of lamb's-quarter plant, badly infested.
FIG 6 Leaf showing spotting and curling.
FIG. 7. First instar.
FIG. 8. Second instar.
FIG. 9. Third instar.
FIG. 10. Fourth instar.
FIG. 11. Fifth instar.
FIG. 12. Adult female.
FIG. 13. Adult male.

PLATE LXVII



THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

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Further Studies on the Reaction of *Opalina* to Various Laboratory Culture Media.

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INTRODUCTION.

THE possibility of growing a parasite outside of its normal host is of the utmost importance in order to study that parasite and to determine its life cycle. During the last twenty years a large number of papers have appeared in which this phase of parasitological research has been emphasized. The technique and culture media have been improved to such an extent that the time does not seem far distant when all pathogenic protozoa can be grown outside of the host.

The intestinal flagellates of various animals, including man, have very readily responded to such treatment, and the first published reports deal more or less with this class of single-celled animals. About 1910 Dock and Bass successfully cultured the malarial parasite, but it was not until 1925 that the very interesting and important pathogenic sarcodine, *Endamœba histolytica* (*dysenteriæ*) was grown in an artificial medium by Bœck and Drbohlav ('25, 3). So successful was the culturing of this ameba on an especially prepared medium that the cultures in the first series of experiments retained their pathogenicity for seven months and more. The organisms were subcultured every forty-eight hours, and at the end of the seven months kittens inoculated with these amebas soon developed serious amebiasis. Different species of the parasitic ciliates have also been cultured. There is only one ciliate, *Balantidium coli*, pathogenic to man, and it has been reported as being successfully cultured. It is interesting to note that parasitic protozoa representing all classes of the phylum have finally been induced to grow and multiply on artificial media.

METHODS AND MATERIAL.

For some time in the Zoölogy Department at the University of Kansas some attention has been given to the study of the ciliate, *Opalina obtrigonoidea,* parasitic in the cloaca of the common leopard frog, *Rana pipiens.* In this series of experiments 166 *Rana pipiens* were examined, and of these 80 proved to be heavily enough parasitized for use.

A paper published by one of us (Larson '28, 6) contains a complete account of how the opalinas were obtained, how the media were made up, and how the cultures were prepared and examined. The same technique was followed in this series, and so the details will not be repeated.

It will suffice to mention that it is very necessary to use well sterilized culture dishes, instruments, etc. It is of the utmost importance to use care in handling these organisms in order to avoid contamination.

Several of the media used in the previous experiments were modified, and therefore those details will be explained. The media most often modified were Cleveland's, Pütter's, Locke's and Ringer's. To 75 cc. of Pütter's fluid was added 25 cc. of blood serum, or 90 cc. of the first and 10 cc. of the second. Lœffler's blood serum was used, and was made up by using one gram of the dry powder to 100 cc. of distilled water heated to 42° C. Pütter's fluid was also modified by adding 250 milligrams of dextrose to 250 cc. of the medium. The main constituent of Pütter's medium is Rochelle salts and this was added to Locke's in the same proportion as given in the original formula for Pütter's fluid.

Locke's and Pütter's were also modified by the addition of egg albumen. To the well beaten white of one egg, 500 cc. of either medium was added and kept in a hot-water bath for 30 minutes. This preparation should be stirred occasionally and then filtered. Some cultures were set up somewhat differently from those reported in the previous paper, since in these experiments the entire absence of the cloacal wall and cloacal content was desired. All of these cultures correspond to those called "clear" in the previous experiments. The number of cultures made from the opalinas in one cloaca was dependent upon the relative number present. In short, each culture dish contained the medium and the opalinas free from fecal material, and most of the bacteria. The number of bacteria present can be very much reduced by passing the opalinas through several changes of the medium. This can easily be done by transferring the parasite from dish to dish by means of a capillary pipette.

DISCUSSION.

As suggested in the introduction, all classes of protozoa have been successfully cultured, nevertheless less work has been done on the ciliates than on any of the others. That was the first thing considered when *Opalina obtrigonoidea* was chosen for these experiments; secondly, this parasite is fairly easy to secure. A continuous supply of material is a very important factor in any line of investigation.

In the published paper (Larson, '28, 6), "Reaction of Opalinas to Various Laboratory Culture Media," the following conclusions were arrived at: (1) *Opalina obtrigonoidea* can be maintained outside of the host for various lengths of time, depending upon the culture medium used. (2) Pütter's fluid is the best of the culture fluids not having blood serum in the original formula. (3) Of the more common laboratory media Locke's fluid is best, with a 33⅓ per cent sea water a close second. (4) Of all the media tried in this series of experiments, a modified serum-saline-citrate proved to be the best for keeping opalinas in process of division and growth outside of their normal host. (5) Any one of the common laboratory media will probably prove to be more effective if serum is added. (6) When culturing with a fluid which does not contain blood serum, a piece of cloacal wall materially helps to increase the longevity of the opalinas in the culture.

Because of the efficacy of Cleveland's solution of serum-saline-citrate, it was decided to try adding blood serum or egg-albumen to some of the other laboratory maintaining fluids such as Locke's and Ringer's, also Pütter's. Pütter's fluid was developed by the German investigator, Pütter, in 1905, and has proven to be an excellent maintaining medium for opalinas. It was developed for the specific purpose of "growing opalinas." The food supply for these organisms is undoubtedly one of the prime factors entering into the problem. Allowing the cloacal content to remain in the culture seems to cause eventually too rapid a multiplication of bacteria. Our first work brought out conclusively the fact that the culture lived longest when there was none or very little of the cloacal content present but with a piece of the cloacal wall in it.

The addition of egg albumen or blood serum in certain definitely worked out proportions materially increased the longevity of the opalinas. This fact makes subculturing more simple because one is not dependent upon a supply of fresh cloacal wall when replenishing the medium in the mass cultures or in making new cultures from the original ones. The following summary shows the results obtained.

Medium	Increase in longevity, in hours.
Pütter's (90 cc.) and blood serum (10 cc.)	72
Pütter's and egg albumen	48
Locke's and egg albumen	24
Locke's (90 cc.) and blood serum (10 cc.)	24
Pütter's and dextrose	None
Ringer's and blood serum	None
Ringer's and egg albumen	None

These are the results from mass cultures where no subculturing was done. Fresh medium was occasionally added because there was some evaporation, in spite of the fact that the culture dishes were always covered.

In Pütter's fluid the opalinas maintained, themselves in mass cultures and without subculturing for sixty-six hours. The addition of the blood serum increased the maintaining power of the medium seventy-two hours. In Locke's fluid the opalinas lived sixty hours, but with the addition of the blood serum to the medium its maintaining power was increased. For further details concerning other experiments with which comparisons are made in this table the reader is referred to an earlier paper (Larson '28, 3).

We regret that at present it is impossible to give a table of measurements for the individual opalinas after fission in the culture medium. (We expect to clear up this matter in the near future.) That would answer the question: Had there been actual growth of the daughter opalina after division? We felt that there must have been some increase in the total bulk of opalina protoplasm. We made numerous observations on opalinas in the process of fission and were quite confident that, owing to the favorable condition of the cultures, especially those that were maintained so long by subculturing, the opalinas which had divided some hours previously were not noticeably smaller than opalinas which had not divided.

Some cultures were subcultered every second or third day. This was more or less dependent upon the condition of the culture. The following sample protocols will serve as illustrations for a great number of experiments worked out in the course of this investigation.

A. Pütter's medium (90 cc.) and serum (10 cc).

March 9, original culture divided into six cultures.
March 11, each culture was subdivided.
March 13, each culture was subdivided.
March 15, each culture was subdivided.

On March 18 culture C of this series of six cultures was in excellent condition, and division had been so rapid that on this date it was divided into four new cultures with fresh medium added. The following is a history of these cultures:

I. Subcultured March 21. All opalinas dead March 23.

II. Not subcultured. Almost all opalinas dead March 23. Culture was destroyed

III. Subcultured March 20, 22, 24. Almost all opalinas dead March 24. Culture was destroyed.

IV. Subcultured March 23, 25, 27. On the 29th so few opalinas were living that the culture was destroyed.

B Pütter—Egg medium.

Four cultures made from original culture April 7.

Each culture had the following history: Subcultured April 9, 12, 14, 16, 18, 19, 23, 25.

On April 14 the C culture of these four cultures was so loaded with opalinas that three new cultures were put together in fresh medium and this culture lasted until April 30.

In all of these experiments where subculturing was done, it is understood to mean the transfer of all the opalinas by a capillary pipette from the old culture medium into a well sterilized watch glass filled with fresh medium of the kind used in the set.

An interesting condition was noticed in one set of cultures where a modified Cleveland's medium had been used. This modification was a 0.1 per cent of sodium citrate instead of 1 per cent as used by Cleveland. The rate of fission was apparently stimulated to an abnormal degree. In the springtime the division of opalinas is normally quite rapid, and it was in that season that these conditions were observed, but this division was very different from all other divisions which we observed macroscopically. Before the parent opalina had completed its fission each of the daughter opalinas had begun division. This peculiar condition was carried to such an extreme that the dividing opalinas presented the appearance of a ball composed of eight or more individuals, none of them completely separated. In some cases they looked like the spokes of a wheel, radiating from a common center. Someone not acquainted with the cultures might have called these dividing opalinas colonial protozoa. We hope to be able to repeat this experiment and to arrive at some conclusion concerning the exact cause of this peculiar condition.

It has been considered very important by several investigators that the media used for maintaining opalinas be made oxygen-free or nearly so. We found it possible, however, to grow opalinas fairly successfully without removing the oxygen from the media. Several of the media were boiled in the process of preparation, all media were kept tightly corked, all cultures well covered, and special precautions were taken in making the transfers. This tended toward eliminating oxygen.

Dr. A. A. Schaeffer, of the Department of Zoölogy at the University of Kansas, offered many helpful suggestions during the course of these experiments.

CONCLUSIONS.

1. The addition of egg albumen or blood serum to any of the more generally used laboratory media will increase considerably the maintaining power of the media.
2. Pütter's medium with the addition of blood serum was found to be the best maintaining fluid. The addition of the egg albumen did not apparently increase its powers for longevity to such a great extent as the serum, but it did increase it beyond straight Pütter's.
3. The maintaining power of Locke's medium is increased several hours by the addition of blood serum or egg albumen.
4. The addition of either egg albumen or blood serum does away with the necessity of retaining the cloacal wall or content in the culture. This undoubtedly reduces the bacterial count, a very necessary factor to consider in any kind of culture work.
5. Subculturing the opalinas makes it possible to keep a culture a month or more for study. It is best to subculture systematically every 24 to 48 hours, depending upon the condition of the culture.

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A Study of the Parasites of the Digestive Tract of Thirty-five Dogs.

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INTRODUCTION.

THE purpose of this paper is to give a survey of the incidence of parasitism in the digestive tract of a random selection of thirty-five dogs from this locality. It is of considerable importance in the field of parasitology to have as complete a record as possible of the parasites of all animals in a given locality. All of these dogs had been used previously for experimentation, but in no case had the digestive tract been disturbed. Arrangements were made so that it was possible to make examination of the tract immediately after the death of the animal.

It is surprising how many parasites are harbored by the dog. There are clinical records of cases where children have actually contracted helminthiasis, as the result of playing with an infested pet dog. The larval stage of a very common dog tapeworm, *Dipylidium caninum,* develops within the flea or louse which is so thoroughly "at home" on the dog. The accidental ingestion of such an infected flea or louse by a dog or man results in the development of the adult tapeworm in the individual ingesting the flea or louse. This particular tapeworm has been reported (Hall '15, 3) from an astonishingly large number of persons in the United States. The majority of such, and similar infections, have been in children.

The writer is greatly indebted to the Department of Physiology of the University of Kansas for the supply of material needed. All dogs were obtained through them.

Miss Mary E. Larson, assistant professor of zoölogy of the University of Kansas, was of great assistance in making this study. Her suggestions were of great value, and are greatly appreciated.

LITERATURE.

To the literature on this subject of parasites of the digestive tract of the dog Maurice C. Hall, of the Zoölogical Division, of the Bureau of Animal Industry of the United States Department of Agriculture, at Washington, D. C., has been the foremost contributor. Dr. B. M. Underhill, in his book entitled "Parasites and Parasitosis of Domestic Animals." sets forth in good form a valuable classification and brief discussions of the various parasites. Many other books and bulletins contain material on this subject, though they are not specially devoted to this field of parasitology.

METHOD OF PROCEDURE.

After the dogs had been killed by excessive etherization the digestive tracts were removed and immediately dropped into normal saline solution. The material was thus kept in excellent condition until it was possible for the examination to be made. Generally, examination was made within the next hour or so. In order to examine the tract carefully it was taken from the normal saline and placed on a dissecting tray. Then, beginning at the posterior end (the lower portion of the large intestine) the tract was slit lengthwise. After laying the digestive canal open, the intestinal contents were removed and examined. The walls of the tract were scraped with a scalpel. All macroscopic animal life was removed by the use of forceps and placed in normal saline for subsequent killing and fixing with corrosive sublimate. After the parasites had been fixed they were placed in seventy per cent alcohol with iodine (the iodine was used to remove the excess of the sublimate) for twenty-four hours. The forms were then preserved in seventy per cent alcohol for further examination and identification. It was often possible to make further observations as to the condition of the dogs internally and externally.

DISCUSSION.

The macroscopic parasites found during the examination of the digestive tract of thirty-five dogs were tapeworms, hookworms, eelworms and whipworms. Tapeworms and hookworms were very frequent, while the eelworms and whipworms. were not so often found. Following is a table showing the number and per cent of the total number of dogs infected by each of the different types of parasites:

Common name of parasite.	Number of dogs infected.	Per cent of dogs infected.
Tapeworms	29	83
Hookworms	29	83
Eelworms	5	14
Whipworms	4	11

It is evident that tapeworms and hookworms were both present in the greater portion of the dogs, but hookworms were not always present if the dog had tapeworms, or tapeworms always present if the dog had hookworms. The following table shows how frequently some of the different types were found in the same host:

Parasites found in the same host.	Number of dogs infected.	Per cent of dogs infected.
Tapeworms and hookworms	18	51.43
Tapeworms, hookworms and eelworms...	5	14.29
Tapeworms, hookworms and whipworms,	3	8.57
Hookworms and whipworms	1	2.86
Hookworms (only)	2	5.71
Tapeworms (only)	3	8.57
No parasites	3	8.57
Total	35	100.00

As to the identification of these various forms little difficulty was encountered except in that of the tapeworms. In determining the genus and species of each form B. M. Underhill's book of 1920, "Parasites and Parasitosis of the Domestic Animals," was found to be exceedingly helpful.

The hookworm, which occurred so frequently, was of the species *Ankylostoma canina* (syn. *Dochmius trigonocephalus; Uncinaria trigonocephalus; Uncinaria canina*), (Underhill '20, 8), and belongs to the family Strongylidæ of class Nematoda. The number of individual hookworms found in one dog ranged from four to hundreds, or more than could readily be picked out and counted. The fact that hookworms are so small made it difficult for one to be sure that all present were found. Generally, each worm was securely fastened to the intestinal wall in the midst of a bloody and inflamed area, which was the result of its activity. As shown in the table above, hookworm infections were usually accompanied by tapeworm, eelworm, or whipworm infection. In every case there were practically twice as many female as male worms. *Ankylostoma canina* is the only kind of hookworm that occurs frequently in the dog of this country. Another species, *Uncinaria stenocephali*, has been reported, but the report has not been confirmed.

Ankylostoma canina produces an affection (Underhill '20, 8) in dogs which is analogous to ankylostomiasis or hookworm disease of man, caused by *Ankylostoma duodenale*. Underhill states that the depression and indifference which result from such infection cause the lack of zest occasionally seen in hunting dogs. The disease usually attacks hunting packs in kennels, where reinfection is easy and the result is that the dogs become anemic, and soon almost worthless, unless treatment is instituted.

It is easy to see how hookworm infection may become common in kennels, but it is truly surprising that it is so frequent among the ordinary city dogs and house pets. Even in the latter cases the infection may become quite severe as can readily be observed by the characteristic harshness and loss of luster of their coats. It is fortunate indeed that this species of dog hookworm apparently never infects man.

The one species of eelworm, or ascarid, common in the dog is *Belascaris marginata*, of the family Ascaridæ of class Nematoda. It is most frequently found in young dogs of three or four months, and it is thought probable that about thirty per cent (Underhill '20, 8) of all puppies harbor the worm in the small intestines. But in our dogs, all of which were adults, *Belascaris marginata* was found in only five of the thirty-five, or fourteen per cent of the group. In one of these only one eelworm was found, but in the others the number ranged from four to nineteen.

The symptoms of eelworm infection are much like those caused by the presence of tapeworms. These symptoms are emaciation, irregular appetite and diarrhea or constipation. The infection of one parasite alone may be disastrous, while with two different kinds, such as eelworms and tapeworms, in a single host, fatal obstruction of the intestinal canal would be the expected results. The intestinal canal of one of the dogs examined was so filled with tapeworms that it seemed impossible that the tract had been able to carry on the process of elimination. Tangled in with this very great mass of tapeworms were a number of eelworms.

The whipworm found in dogs is *Trichuris depressiusculus* (syn. *Trichocephalus depressiusculus*), (Underhill '20, 8), of the family Trichinellidæ of class Nematoda. This peculiar worm was found to occupy the extreme tips of the ceca of four of the thirty-five, or eleven per cent of the dogs examined. They were not found in great numbers; the average per dog was eight worms. Each case of whipworm infection was accompanied by hookworm infection. There is no knowledge of these worms of the dog being of any pathogenic importance, but the whipworm of man, *Trichuris trichura,* has been suggested as playing a part in the development of a diseased appendix (Chandler '20, 1).

The life cycle, the abundance, and the appearance of the tapeworms of class Cestoda make them of greater interest than the above-considered forms. They were found in eighty-three per cent of the dogs examined, and in the majority of these cases they were quite abundant. The following table gives the names and the frequency of the different tapeworms found. Identification was made on external characters principally. Underhill's book was the main source of descriptions.

Name of tapeworm	Number of dogs infected.	Range in numbers of worms per dog.
Dipylidium	23	2-50
Tænia pisiformis	11	1-46
Tænia hydatigena	3	1-16
Multiceps	8	2-17
Unclassed ones (very small)............	5	2-200

It was impossible to determine the species of *Multiceps.* There are possibilities of two species of this genus being present (*Multiceps multiceps* and *Multiceps serialis*). However, the chances are that the majority are *Multiceps serialis.* Underhill '20, 8, says that dogs having access to butchers' offal are often infected with *Multiceps multiceps* and *Tænia hydatigena,* the cystic forms of which are harbored in organs of sheep; while hunting dogs and those which roam about are more frequently infected with *Multiceps serialis* and *Tænia pisiformis,* which have their larval stages in rabbits. With all the modern equipment used by the butchers and packing houses to-day the accessibility of dogs to the wastes of the various animals is greatly reduced. Unless the cyst of *Multiceps multiceps* is obtained from the sheep of such places it is hard to imagine where they could get them, since very few sheep are raised in this territory. There are, however, many rabbits in this region of the country, so that all the dogs would easily have access to the cysts of *Multiceps serialis.* The scarcity of sheep in this territory probably also explains the fact that there were comparatively few dogs infected by *Tænia hydatigena.*

It is difficult to determine the species of the genus *Dipylidium* without making microscopic examination. *Dipylidium caninum* is quite generally accepted as the most common species of this genus. The fact that the cystic stage of *Dipylidium caninum,* the double-pored tapeworm, is in the flea or louse of the dog may explain the very great frequency of the presence of this genus of tapeworms.

Dipylidium was found in twenty-three, or seventy-nine per cent, of the twenty-nine dogs infected with tapeworms; or in sixty-five per cent of the thirty-five dogs examined. Some were only five or six inches long, and were quite slender, though mature. Others were fifteen inches long, and the mature and gravid proglottids were large. These worms were always found in considerable numbers whenever present at all.

Some of the specimens of *Tœnia pisiformis* had some very peculiar proglottids. Many of the worms were made up (wholly or partially) of proglottids, which were almost circular in shape and were only loosely attached to each other. The "chain" of such proglottids was extremely easy to break. Perhaps this condition was due to some degeneracy that was taking place in the tapeworm; but the writer has no definite explanation to offer.

The muscular activity of the individual gravid proglottids was often noticed with interest. In one instance, a number of them were placed in a water glass of normal saline solution and their peculiar activity was watched closely for four hours. After being unobserved for ten hours some of them were found to be still moving, but the movement was quite slow, and all died within the next two hours.

An interesting tapeworm is the three-sided one found in one dog (dog 26), which was very heavily infested with worms. This dog was host to ninety good-sized tapeworms besides the hundreds of the so-called small "unclassified ones." This somewhat unusual worm is eight inches long (preserved; during fixation it had no doubt contracted a great deal). Each proglottid, from the youngest to the most mature, is triangular in cross section. Dr. Maurice C. Hall says it "is one of the trihedral tapeworms, and this form of abnormality has been reported a number of times for a number of species." This one is of the species *Tœnia pisiformis.*

The tapeworms recorded as "unclassified ones" were small, not more than two and a half inches long, and quite slender. Some of the forms were mature, as was readily observed by the shape and the structure of the posterior proglottids. In one dog only two of them were found, while in another there were about two hundred. At first glance they resembled immature members of the species *Dipylidium caninum,* but the fact that these small forms were mature makes it very unlikely that this was the case. Hall and Wigdor ('18, 5), make reference to a species which may be the worm under consideration here. This tapeworm is called *Dipylidium sexcoronatum,* and is thought to be almost as common in Detroit, Mich., as *Dipylidium* *caninum*. The description given by the above authors in this paper was not sufficient to determine whether or not the worms found here were of the same species. The frequency is sufficient to suggest the possibility of these worms being *D. sexcoronatum* found to be common in Detroit. They are undoubtedly of the genus *Dipylidium,* as they are double-pored, but the author is as yet unable to determine the species.

It was found that each parasite had a characteristic distribution in the digestive tract. The tapeworms were generally found in one great mass, and were usually all in the ileum. Only in one instance was there only a single tapeworm (*Tœnia pisiformis*), and it was near the pylorus (Sisson '17, 6). Only gravid proglottids, which had been shed, were found in the cecum or colon. The hookworms were usually scattered the full length of the small intestine, but if there were only a few, they were in the ileum. A few times some were found in the cecum, or the anterior region of the colon. Once a few were found in the stomach. The eelworms seemed to have no particular choice as to what region they occupied except that it be in the small intestine. When they were quite numerous the younger ones occurred anterior to the large ones. The whipworms were always found at the extreme tip of the cecum.

Dogs serve as intermediate hosts to parasites which cause a great economic loss in the raising of domestic animals. The "gid" parasite (Hall '10, 2 and '20, 4) which occurs in the brain or spinal cord of sheep, is the cystic stage of *Multiceps multiceps,* a tapeworm of the dog. Dogs should be kept free from tapeworms of any kind, and various means of treatment for removal may be used (Hall '20 4). If infection, of any type of parasites, is realized it would be advisable to administer treatment. The parasitism of dogs is a decidedly serious problem worthy of thoughtful consideration. We are all so familiar with the habits of the dog that the possibilities of it being a carrier of disease cannot be overlooked.

CONCLUSIONS.

1. Most of the dogs of this territory are infested with a number of different kinds of parasitic worms of the digestive tract.
2. The parasites found in the digestive tract of the thirty-five dogs examined were tapeworms, hookworms, eelworms, and whipworms.
3. Eighty-three per cent of the dogs examined were infected with tapeworms.

4. Different species of the cestode genera *Dipylidium, Tænia* and *Multiceps* were found in these dogs.

5. Eighty-three per cent of the dogs examined had hookworm infection. All hookworms were of the species *Ankylostoma canina.*

6. Fifty-one per cent of the dogs had both tapeworm and hookworm infection; but all dogs having tapeworm infection did not have hookworm or other parasitic infection.

7. Five per cent of this group of dogs were infected with eelworms of the species *Belascaris marginata.*

8. Four per cent of the dogs were infected with whipworms of the species *Trichuris depressiusculus.*

9. Eight and one-half per cent of the thirty-five dogs harbored no parasites in the digestive tract.

10. Few sheep are raised in this territory; therefore, few tapeworms of the species *Multiceps multiceps* and *Tænia hydatigena* were found, because they must have the sheep to harbor their cystic stages.

11. The parasitism of dogs is a problem worthy of consideration.

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Relations Between Plants and Birds in the Missouri River Region.

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IN making a study of the birds of a small area bordering the Missouri river in northeastern Kansas special attention was given to the recording of facts bearing upon the relations of particular kinds of plants to birds. All observations herein recorded were made within one and one-half miles of the old townsite of Geary, Doniphan county, Kansas, and between 1921 and 1925.

Although it is now generally recognized that the vegetation of a region has an important and well-defined influence upon the bird life of the region, there are few published papers which deal with this phase of bird study. Since so few studies of bird life have been made from this viewpoint, it is thought desirable to record observations somewhat in detail rather than to make general statements without presenting the data on hand which indicate the nature of the relationships that exist between the various kinds of plants and the birds of the region.

Particular plants of this area were found to influence certain birds by furnishing: (1) Suitable nesting sites; (2) food; (3) shelter, resting places, screen; (4) nesting materials.

A brief account of other factors which influence birds in ways similar to plants is added.

INFLUENCE OF IMPORTANT PLANT GENERA.

Acer. Two of the species of larger trees of the area belonged to this genus. The white maple (*Acer saccharinum*) was a common tree where it had been planted in yards and in other places near houses. The trees were usually not crowded so that there was plenty of room for the tops to become large and for large limbs to develop.

A few birds gathered insect food from the branches of the maples. This tree did not furnish especially suitable nesting sites, and only a few species nested in it. One nest of the mourning dove was found thirty feet from the ground on a large sloping limb of a maple. A blue jay's nest was found on a similar limb three inches in diameter. Another was seen building a nest in a crotch made by two limbs and twenty feet from the ground. A third nest of the blue jay was twenty-five feet from the ground. The Baltimore oriole placed nests in the ends of drooping branches. A nest of this species was placed ten feet from the ground A red-eyed vireo's nest was found hanging from a horizontal fork of a limb three-eighths of an inch in diameter, seven feet from the ground, in a tree forty feet high that was growing on the bar east of the lake. Robins built a nest four feet from the end of a small branch in the top of a maple.

The box elder (*Acer negundo*) was more generally distributed over the area than was the maple. This tree was found in yards, along the road on the lower part of the bluff, along the creek and ravines, and in the older parts of the bar. In addition to the supply of insect food on its leaves and branches, the crop of seeds of this tree furnished some food for winter seed-eating birds such as cedar waxwings. Most individuals of this species were not large A mourning dove's nest was found ten feet from the ground on a horizontal limb. Yellow-billed cuckoos nested in similar situations Bronzed grackles were found nesting in the tops of trees of this species that were growing along a creek. A cardinal's nest was found six feet from the ground in a small, bushy box elder. Rose-breasted grosbeaks nested on horizontal limbs ten feet from the ground and in a position similar to that selected by one pair of summer tanagers for a nest site. A red-eyed vireo built a nest nine feet from the ground in a medium-sized tree along the lower part of the bluff Robins nested in an upright crotch twelve feet from the ground and on a horizontal limb fifteen feet from the ground. Blue jays nested in a crotch near the top of a tree and thirty feet from the ground.

Ambrosia Several kinds of weeds, including *Ambrosia, Cannabis, Amaranthus, Chenopodium, Melilotus* and *Rumex* grew in dense tangles in patches of waste ground over all the area, and especially in fence rows, roadsides, on waste parts of the bar, in fields that were not well cultivated or that were not planted to crops, and in artificial clearings on the bluff. These dense growths were from five to ten feet high. During the summer there was some insect food on these plants, but they were of most use to birds in furnishing nest sites. The indigo bunting and dickcissel were common nesters in these weeds. Their nests were usually placed from two to four feet from the ground. Redwinged blackbirds nested in patches of rumex that grew near the lake.

In August and early September these weeds furnished an abundant supply of insect food and many resting places for the smaller species of migrating birds. Some of the more frequent species in these flocks were the orchard oriole, Baltimore oriole, indigo bunting, dickcissel, blue-headed vireo, Bell's vireo, worm-eating warbler, Nashville warbler, orange-crowned warbler, Tennessee warbler, Kentucky warbler, mourning warbler, Maryland yellow-throat, yellow-breasted chat, Wilson's warbler, Canada warbler, catbird, and western house wren.

During the winter months many of the seed-eating birds spent their time feeding on the large crop of seeds produced by these weeds. The species which regularly fed there at this time are: Downy woodpecker, red-winged blackbird, purple finch, goldfinch, pine siskin, Harris' sparrow, white-throated sparrow, tree sparrow, slate-colored junco, song sparrow, Lincoln's sparrow, swamp sparrow, fox sparrow, towhee, cardinal, indigo bunting, English sparrow, mourning dove, and chickadee The winter wren, golden-crowned kinglet, and ruby-crowned kinglet were sometimes found in the weeds.

Celtis. The hackberry (*Celtis occidentalis*) is not a dominant tree of the region, but it exerts an influence upon the bird life. The larger trees of this region were found in yards and along the creek. Others grew along the bluff and especially along its lower part. In addition to the usual amount of insect food found on the foliage of this tree, there was each year a crop of fruit which ripened in the fall and which was on the tree through the winter. Cedar waxwings and robins were seen feeding on the fruit of this tree.

A nest of the mourning dove was found on a hackberry limb thirty feet from the ground. Orchard orioles nested on the end of a branch fifteen feet from the ground.

Cercis. The redbud (*Cercis canadensis*) is one of the more important of the smaller trees of this region to birds. It is found along the creeks and in sprout fields, and as an invader on the river bluffs. It grows usually as a small, spreading tree with a rounded top and many branches. In the more crowded situations this tree grows taller and with fewer branches. In this form the tree is less favorable for use by birds than it is when rounded. During the latter half of April redbud trees are in flower, and they attract many small insects, which in turn attract the flocks of small, migrating, insect eating birds, many of which do most of their feeding at about the level of the tops of redbud trees.

Several species of small summer residents found suitable nesting sites in redbud trees. A nest of the mourning dove was found on a leaning main trunk and nine feet from the ground. This tree furnished one of the most favorable nest sites for the yellow-billed cuckoo, five nests being found in the bushy tops from four to twelve feet from the ground. A nest of the cardinal was found in a fork three and one-half feet from the ground. A nest of the yellow-breasted chat was found four feet from the ground on a redbud sprout. A natural cavity, four and one-half feet from the ground, in a main trunk of a redbud, held a nest of a tufted titmouse.

Cornus. The rough-leaved dogwood (*Cornus asperifolia*) was one of the most abundant of the secondary trees, both on the bluff and in the later stages of growth on the bar. Dogwoods were also found growing in the bottom-land timber along the creek. The tree usually grew with a spreading top of many branches that were covered with a thick growth of leaves. These trees were usually not over fifteen feet high.

In addition to the insect food that birds find in the leaves and on the branches of dogwood, there is a large crop of white fruit that ripens in August of each year, and which is a popular food supply for large flocks of birds that gather before and during the first movements toward the south in the fall. This fruit ripens about the last of August and usually hangs on the tree until it is eaten by the birds. Some of the species most often seen feeding on the fruit of dogwood are the kingbird, catbird and brown thrasher. A red-bellied woodpecker was seen picking the fruit, which it ate.

A screech owl was found hiding in the thick tops of a thicket of dogwood that was growing along the lower edge of the bluff.

At least eight species of birds found suitable nesting sites among the branches of the dogwood. Two nests of the yellow-billed cuckoo were found on horizontal branches five and six feet from the ground. Two nests of the cardinal were found in dogwood sprouts, and two nests of the indigo bunting were found in the thick tops of small dogwoods. These nests were well hidden by the leaves. A pair of red-eyed vireos nested on the end of a limb of dogwood five feet from the ground. Two nests of Bell's vireo were found at the ends of lower branches of dogwoods on the bar and within three feet of the ground. Yellow-breasted chats nested on a dogwood sprout and three feet from the ground. A nest of the brown thrasher was found in the top of a dogwood eight feet from the ground. Two nests of the wood thrush were found in forks of a main trunk seven feet from the ground.

Hicoria. Several species of hickory trees were found in the timber on the bluff. *Hicoria ovata* was the most common of these, and affected the bird life a little more than did the other species. The hickory is one of the largest trees in this region, the size being partly dependent upon the thickness of the soil covering over the rocks and the nearness of other trees. When the trees grow close together the trunks are limbless for several feet, and the tops are small and consist of few branches.

Several species of birds hunted over the trunks and limbs for insect food in winter, and hunted in the leafy branches in summer.

Not many species of birds nested in hickory trees. The larger trees, so far as is known, furnished nesting sites for only two species of birds. Two nests of the ruby-throated hummingbird were found on small horizontal branches twenty feet from the ground. A nest of a pair of scarlet tanagers was found on a larger limb twenty feet from the ground. A nest of the cardinal was found six feet from the ground on a hickory sprout. A pair of red-eyed vireos built a nest near the end of a branch of a sprout and eight feet from the ground.

Juglans. The black walnut is one of the larger trees in the richer portion of ground along the creek, in low places on the bluff, and in yards. When not too crowded this tree produced a large crown with large branches. Some large walnut trees that were dying furnished good perches for woodpeckers and flycatchers and other birds that require exposed perches for considerable periods of time. The large tops furnish feeding grounds for many small species of insect-eating birds during the spring migrations. The walnut prefers rather rich soil, and it usually grows where the soil is sufficiently deep for a large tap root to be sent down.

This tree furnishes poorer nesting facilities than do some of the other kinds of large trees. Mourning dove's nests were found on horizontal limbs ten feet from the ground and twenty-two feet from the ground. A nest of the yellow-billed cuckoo was found on a small lower limb of a walnut that was seven feet from the ground.

Three nests of the Baltimore oriole were located on the ends of walnut limbs at heights of from twelve to thirty feet from the ground. A nest of the dickcissel was four feet from the ground on a walnut sprout. A pair of blue-gray gnat catchers built a nest in the crotch of a small limb twenty feet from the ground. A robin's nest was found on a horizontal limb twenty feet from the ground.

Maclura. The Osage orange, or hedge (*Maclura pomiferum*), is not a native tree in this part of Kansas, but it has been introduced, and it furnishes an excellent protection for many kinds of birds as well as very good nest sites for some. This plant is usually set out in rows to serve as fences to mark the boundaries of fields and pastures. Sometimes it is kept closely cut back, and its growth regulated so that it makes a dense low thicket. Some trees were found growing singly in pastures where they had grown up after escaping from the fences. These trees were usually the center of a small thicket, which was always popular with thicket-inhabiting birds. Most of the Osage-orange trees on the area studied are in fences that have not been trimmed or otherwise disturbed. Most of these fences are along roads, and they have a belt on either side of from ten to twenty feet that has grown up with shrubs and weeds that meet the lower branches of the trees in the fence, and so make the tangle more dense.

In addition to the birds that find food and protection from the wind and predatory animals, there are several species that use these thickets for nesting sites. These nests of the mourning dove were found in Osage-orange trees. A yellow-billed cuckoo's nest was found eight feet from the ground on a horizontal limb of one of these trees. Cardinals nested six feet from the ground in a hedge fence. A pair of Bell's vireos built a nest five feet from the ground on the end of a limb of a tree in a fence. Brown thrashers built a nest five feet from the ground, but in the center of a fence, and near the main trunk of a tree.

Morus. The red mulberry (*Morus rubra*) grew scattered throughout the timber as a small tree which was not important for birds. This tree in summer produces a large crop of soft fruit that is used as food by birds; but the number of trees in this area was small and the trees themselves were not large enough to produce a fruit crop of sufficient size to influence the feeding of many birds. A red-bellied woodpecker was seen hovering at one tree and picking the ripe berries, which it ate.

Mulberry trees seemed to be unsuitable for nesting sites, and only one nest was found in one. This was a cardinal's nest that was eleven feet from the ground and which was shaded by a vine.

Nelumbo. The chinquapin, or lotus (*Nelumbo lutea*), was an important plant in the stages of the lake when the water was shallow, and it contributed largely to the filling up of the lake. The leaves usually started to grow rather late in the spring, and they could not be seen above the water until about the first of June. The plants grew rapidly, and within a few weeks the large leaves, two feet or more in width, and the stalks, four or five feet high, were grown and the large yellowish-white flowers were produced. Most of the flowers were gone before the end of August. During September the large heads, three to five inches in diameter and containing twenty to forty seeds each, grew and ripened. During the first part of October the plants dried up and died. The material in the stem and leaves was added to the bottom of the lake. This plant grew in large patches that rapidly spread into all parts of the lake where the water was of suitable depth.

The lotus was of value to birds for the food which it produced in the seeds and as a screen for the birds that feed in the shallow water and on the mud. In the winter crows spent a great deal of time at the lake, feeding on the lotus seeds which they picked out of the heads. They obtained these either from the mud at the edge of the lake or from the ice in the lake. Wood ducks that fed in these patches of plants may have eaten some of the seeds. Other birds that were found in the lotus patches, probably because of the need for a screen and possibly because other kinds of food were more abundant there than elsewhere, are: Shoveller, bittern, great blue heron, green heron, sora, coot, Wilson's snipe, solitary sandpiper, spotted sandpiper, killdeer and the Louisiana water thrush. In the fall red-winged blackbirds settled on the stems of this plant to roost and to rest. Spotted sandpipers were a few times seen walking on floating leaves of the lotus.

Platanus. The sycamore (*Platanus occidentalis*) grows in the timber along the creek and near the lower edge of the bluff, both on the bar and on the bluff. The sprouts of this tree are bushy and are suitable for nesting. The medium-sized trees are spindling and have little-spreading limbs, and are not especially desirable for nest locations. The limbs of the larger trees, which grow in places where they are not crowded, are nearly horizontal and some of them are near the ground. These furnish many desirable nest sites.

Two nests of the kingbird were found twelve feet from the ground in sycamores. One was on a horizontal limb and was in a fork next to the main trunk. Nests of the wood pewee were found near the ends of limbs that were twenty-two feet and thirty feet from the ground. A nest of the cardinal was found seven feet from the ground on a horizontal limb of a small sycamore. Indigo buntings nested three feet from the ground on a sycamore sprout. A natural cavity near the ground in a large sycamore near Doniphan lake was used by a nesting pair of prothonotary warblers. Tall sycamore trees along the lower edge of the bluff were favorite singing perches and feeding places for small birds, and especially the parula warbler.

Polygonum. In the early part of the summer of 1923, when the lake was nearly dry, a large part of its bed was covered with a dense growth of smartweed. Later, when the overflow from the river flooded the lake, the smartweed remained and continued to grow until fall, when the plants died, and after the seeds were mature fell into the water. They did not grow in the summer of 1924. In the fall of 1923 several kinds of birds were flushed regularly from the patches of smartweed. Some of them may have been feeding on the seeds of *Polygonum.* The birds most frequently seen were mallard, blue-winged teal, bittern, great blue heron and coot.

Populus The cottonwood (*Populus deltoides*) was one of the dominant trees on the bar along the river. It was found in varying sizes from very young saplings to trees forty or fifty feet high. Nearly all of the taller trees were along the lower edge of the bluff or along the creek where the soil had not been disturbed for a number of years. Nearly all of the trees of this species were between fifteen and twenty years old and had trunks about eight inches in diameter.

The medium-sized cottonwood trees furnished food and resting places for a large number of species of smaller birds at all seasons. Black-crowned night herons were frequently found roosting, during the day, in the tops of cottonwoods. Various species of hawks used these trees as lookout perches.

This tree was not especially desirable for nesting. Most birds did not find suitable sites in its branches. Green herons nested in a fork twenty feet from the ground. Yellow-billed cuckoos nested near the main trunk on a limb fifteen feet from the ground. Five nests of the crow were found, from ten to twenty feet from the ground, in cottonwood trees on the bar. One of these nests was used for nesting during a second season by a pair of long-eared owls. Cardinals nested six feet from the ground in a small cottonwood that had fallen over and whose leaves had dried. Orchard orioles nested in the top of one of these trees. A nest of the indigo bunting was found nine feet from the ground in a cottonwood sapling. The warbling vireo, although no nests were found, preferred and was usually found in the tops of medium-sized cottonwoods on the bar. Bell's vireo nested five feet from the ground in the end of a branch of a small sapling. A nest of brown thrashers was fastened between two trunks of cottonwood at a height of four feet from the ground.

Prunus. A few peach trees were found in the orchards, as well as a few plum and cherry trees. There were a few wild plum and wild cherry trees on the bar and along the roads. These trees were present in too small numbers to have much influence upon the bird life. In the summer most of them bore fruit that attracted birds. A catbird was seen carrying ripe cherries from an orchard.

Brown thrashers built a nest four feet from the ground in the center of a plum thicket. Mourning doves built on a horizontal limb of a peach tree in an orchard.

Pyrus. Apple trees (*Pyrus malus*) were planted in orchards at most of the houses within the area. These trees were nearly all old, and as they had not been trimmed or properly cared for, many of them were dead or dying. The insects that came to the flowers on the trees in the spring attracted many birds, and apple orchards that were not regularly sprayed furnished an abundant supply of insect food throughout the summer. The wild crab-apple trees that grew on the bluff were also good feeding grounds for many small species of birds.

The low and wide-spreading limbs of the apple trees furnished desirable nest sites for several species of birds. Mourning doves nested twelve feet from the ground in an apple tree. A nest of the kingbird was found in a fork twelve feet from the ground. Rose-breasted grosbeaks nested in the center of the crown of an apple tree and about fifteen feet from the ground. A catbird's nest was found nine feet from the ground in the center of a bushy top of a small tree. Robins nested thirteen feet from the ground in the top of an apple tree. Downy woodpeckers and bluebirds nested in holes that had been made by the woodpeckers in the main trunks and large limbs of apple trees.

Quercus. Oak trees of several species (*Quercus rubra, Q. macrocarpa, Q. coccinea,* and *Q. alba*) make up the most abundant and most important trees on the bluff. Oaks were also found along the creek. Oak sprouts came up in the cut-over fields that were not kept in cultivation. Some of the largest trees on the area were oaks. The size of the tree depended on the nature of the soil as well as the age of the tree. The trees which grow near the outcrops of rock, where the soil is thin, are usually smaller than those that grow in deeper soil. The trees are usually crowded, so that they are tall and have small tops with few branches near the ground. Large numbers of birds find insect food on oak trees, on the leaves in summer and on the trunk and limbs in winter. Blue jays and red-headed woodpeckers ate the acorns that ripened in the fall.

Oaks of all sizes are suitable for nesting, and a large number of species prefer to build their nests in them. A mourning dove was seen building a nest on a horizontal limb of an oak fifteen feet from the ground and fifteen feet from the main trunk. A nest of Cooper's hawk was found thirty feet and another twenty-five feet from the ground. Both were in forks of the main trunks of medium-sized oak trees. A red-tailed hawk's nest was found twenty-five feet from the ground in a fork of an oak tree whose trunk was one foot in diameter at the base. Yellow-billed cuckoos selected a variety of nesting situations in oaks. One nested four and one-half feet from the ground in a sprout. Another nested on a horizontal limb ten feet from the ground. It was five feet from the main trunk. A third nest was found in the top of a tree and twenty feet from the ground. Seven nests of the ruby-throated hummingbird were found saddled on small twigs near the ends of oak limbs and from ten to twenty-five feet from the ground. Two nests of the wood pewee were found on horizontal limbs of oaks that were twenty feet above the ground. A pair of Acadian flycatchers built a nest six feet from the ground in the end of a lower limb of a medium-sized oak. The material in the nest was chiefly staminate flowers of oak. A crow's nest was found twenty feet from the ground in a fork of an oak. Baltimore orioles were seen feeding young in a nest at the end of a limb in the top of a tree thirty-five feet high. A nest of the field sparrow was found three feet from the ground in an oak sprout eight feet high. Cardinals nested five feet from the ground in an oak sprout. Two nests of the summer tanager were found on horizontal limbs about fifteen feet from the ground. A red-eyed vireo's nest was found hanging from the end of a lower limb of an oak and five and one-half feet from the ground. Brown thrashers nested three feet from the ground in a sprout. Tufted titmice nested in a natural cavity in the main trunk of an oak and five and one-half feet from the ground. Three nests of the blue-gray gnatcatchers were found near the ends of limbs in the tops of oak trees and twenty feet from the ground. A wood thrush's nest was seen eight feet from the ground on a lower horizontal limb.

Trees of this genus furnish much better nest sites than any others that grow on the bluff in this region.

Rhus. Several species of this genus were found in the area. Sumac (*Rhus glabra*) was found frequently as a good-sized shrub, that grew at the edges of the timber on the bluff, in pastures and in clearings in the timber. A large supply of seeds ripened in the fall and stayed on the plant during the winter. Robins and bluebirds were seen feeding on these seeds. The poison ivy (*Rhus toxicodendron*) climbed over the trees in the timber. It also produced a fruit which birds ate.

Yellow-billed cuckoos nested four and one-half feet from the ground in sumac. A pair of indigo buntings nested four feet from the ground in sumac.

A cardinal's nest was found in a vine of poison ivy that was climbing up the trunk of a cottonwood. The nest was nine feet from the ground.

Ribes. Two or more species of gooseberry (*Ribes* sp.) grew as important plants in the secondary layer of vegetation of the timber on the bluff, along the creek, and on the bar. Clumps of these plants growing together often made dense thickets five or six feet high and several feet in diameter. In these, protected by a dense cover of leaves and by the many thorns on the stems, catbirds and brown thrashers nested.

Rosa. Wild rose bushes grew in clumps on the older parts of the bar, in the timber on the bluff, and along the creek. Each clump furnished a good protection because of the many sharp thorns. Sometimes these roses climbed over other plants or objects. A yellow-billed cuckoo nested six feet from the ground in one of these vines. A nest of the cardinal was found five feet from the ground in the top of a rose bush. Yellow-breasted chats nested in wild rose bushes.

Salix. The willows were dominant trees in the early stages in the development of the bar along the river. They normally cover the bars for the first few years after they are formed. Willows, of all sizes from the small saplings to trees thirty or more feet in height, were present on the bar during the period of this study. Several species were present. Some were found in a narrow line along the creek. Plants of this genus were used by birds for the important activities of nesting, resting, and hunting food more times than were plants of other genera in this area.

Possible reasons for this apparent popularity of the genus Salix are the great number of individuals of this genus on the area and the great variety of form of those plants due to difference in age. Plants of this genus had an influence upon some important activity of at least seventy-one species of birds during the time that these studies were being made. A great number of these birds were seen feeding on the numerous insects that were found on the willows. These feeding birds were especially numerous in the late summer and during the early fall migrations. Some birds were seen picking bagworms from coccoons in winter. Most of the growth of willows on this bar took place during the first fifteen years after the bar was formed. During this time they were being continually thinned. After they stopped growing other trees, especially *Populus,* overtopped them and crowded them out.

Several species of birds, especially flycatchers, used willows as perches where they waited for flying insects to come near. Others rested in the trees. Owls and herons used them in this way.

Willows provided a variety of situations suitable for nesting sites. Mourning doves nested on a dead willow stump that was two feet above the water in the lake A nest of the yellow-billed cuckoo was found in a similar location, and one was found seven feet from the ground in a living tree A red-winged blackbird's nest was found in a willow four feet above the water of the lake. Two other nests of this species were five feet from the ground in willows growing on the bar. A pair of orchard orioles built a nest thirteen feet from the ground in the top of a willow. A nest of the Baltimore oriole was seen in the top of a large willow tree. Nests of the cardinals were found in willows three, five, eight and ten feet from the ground. Two nests of the indigo bunting were located in willows, and were about five feet from the ground. Four nests of the Bell's vireo were found that were fastened to the ends of small twigs, from two and one-half to five feet from the ground, in small willow saplings. Yellow warbler's nests were found five and eight feet from the ground in forks of the main trunks of slender willows. Two nests of the yellow-breasted chat were found in forks of small willows two and one-half feet from the ground. A catbird's nest was found in the fork of a small willow tree four feet from the ground. A nest of the wood thrush was fastened fifteen feet from the ground and adjacent to the main trunk of a willow on the bar. Birds that nested in cavities of dead willows are: Tree swallow, prothonotary warbler, downy woodpecker, western house wren, chicadee, and bluebird.

Sambucus. The elder (*Sambucus canadensis*) was a common shrub in pastures and sprout fields, in thickets at the edge of the timber on the bluff, and was prominent in the secondary layer of shrubs on the bar. It was also found in clearings in the timber and along the roads. This plant produces a rich crop of fruit in late summer, and several kinds of birds fed on it. The berries are dark red and hang in clusters in the tops of the bushes. The bushes were not high, and did not furnish especially good nesting sites for birds, but four smaller species found them suitable.

Acadian flycatchers built a nest, hanging from the end of a branch five feet from the ground. Four nests of the cardinal were found, four to six feet from the ground, which were placed in forks in the centers of the bushes. Indigo buntings nested one and one-half feet from the ground in a small elder. Three nests of the dickcissel were found from two to four feet from the ground in the forks of elder.

Symphoricarpos. The coral berry (*Symphoricarpos orbiculatus*) was a common, small shrub at the edges of the timber, in partial clearings, along roads, and in pastures. It grew in scattered bunches or in small clumps that were from three to five feet high. The stems of the plant are small and tough. The small leaves are close together and make a good screen. Five species of birds nested in these bushes.

A nest of the field sparrow was found one and one-half feet from the ground in a clump of coral berry. Three nests of the cardinal were found from three to four feet from the ground. Three indigo bunting's nests were found that were one, two and two and one-half feet from the ground. A white-eyed vireo's nest was seen that was two feet from the ground. Two nests of the yellow-breasted chat were two and two and one-half feet respectively from the ground.

Typha. The cat-tail (*Typha latifolia*) grew in and around the lake in dense patches that were almost pure stands. The old growth each year did not fall back entirely to the ground, and the new growth was added to make the thicket more dense. This made a good hiding place for the birds usually found in such situations. Birds found an abundance of insect food in patches of cat-tail as well as good cover and, for a few species, good nesting sites. For every use this was one of the more important plant genera on the area. The activities of at least twenty-five species of birds were found to be related to *Typha*. Grebes, ducks, herons, rails, coots, snipe, sandpipers and water thrushes swam or waded among the cat-tails to feed or to hide. Tree, song, Lincoln's, and swamp sparrows, Maryland yellowthroats, and winter wrens fed or rested among the stems of cat-tail that were out of the water, more frequently in winter and during the migration seasons than in the summer. Purple martins and tree swallows roosted in large numbers in the cat-tail thickets in the fall.

Yellow-headed blackbirds, red-winged blackbirds and prairie-marsh wrens were found nesting among the cat-tails, usually over the water. A few other species may have nested there, or probably will in future seasons if the growth is allowed to continue and accumulate. Most of the species which nested in the cat-tails required some growth from the previous season to help support and hide their nests. The new growth of a single season is not sufficiently dense.

Ulmus. Two species of elm were found—the white elm (*Ulmus americana*) and the slippery elm (*Ulmus fulva*). The white elm is a dominant tree in the timber on the bluff. It is common along the creek, and is found in the farmyards. Under favorable conditions this is one of the largest trees in the area. The trunks, branches and leaves supply an abundance of insect food for many species of birds. The leaves are especially dense and furnish hiding places for birds like the screech owl.

In some of the older elms there were cavities in which several species of birds nested. Six nests of the mourning dove were found from six to thirty feet from the ground in elms. Those near the ground were in smaller trees. One nest of the yellow-billed cuckoo was found ten feet from the ground on a horizontal limb of a small elm. A ruby-throated hummingbird's nest was seen on a small twig of an elm fifteen feet from the ground. Four nests of the blue jay were found in elm trees. One was twelve feet from the ground in a fork near the main trunk. The others were on limbs that were horizontal or nearly horizontal and were from twenty-five to thirty feet from the ground. A crow's nest was found in a fork of the main trunk of a medium-sized elm and twenty-five feet from the ground. A nest of a pair of orchard orioles was placed in the end of a lower limb and seven feet from the ground. Four nests of the cardinal were found in elms. Three of them were in saplings, and were from three to six feet from the ground. The other was in a low, drooping limb of a large tree, and was within nine feet of the ground. A white-eyed vireo's nest was found one and one-half feet from the ground and hanging from a small twig of a sapling. A small tree had a catbird's nest saddled on a branch next to the main trunk and six feet from the ground. A nest of the blue-gray gnatcatcher was placed twenty-five feet from the ground and was saddled on a small limb near the top of the tree. Three nests of the wood thrush were found on lower limbs of elms. They were all about twelve feet from the ground. A robin nested in an elm and twenty feet from the ground.

Vitis. The wild grape (*Vitis vulpina*) was found as a climber throughout the timbered land on the bluff, along the creek, and on the bar. It also grows along fence rows and roads. By means of tendrils the vine grows over trees, bushes, fences and other objects so that the leaves may reach the light above. The large leaves help to make a dense shade over whatever the vine covers.

Screech owls rested in the dense shade of the grapevine during the day. In late summer and early fall many of these vines bore a heavy crop of fruit, which was eaten by several species of birds. The tendrils and shreds of bark provided materials for nest building for birds, especially the cardinal. The birds that built nests in grape vines are: Yellow-billed cuckoo, cardinal, indigo bunting and the yellow-breasted chat. As a rule the nests were placed in shaded portions of the vines. The grape was the most important vine for the birds of the area.

INFLUENCE OF OTHER ENVIRONMENTAL FACTORS.

BARE GROUND.

Bare ground was found on some of the newly formed islands in the river, along the recently exposed portions of the lake shore, in the roads, in farmyards, and in freshly plowed or burned fields. No birds were found nesting in these situations within the limits of this area. Pelicans and Canada geese rested on the exposed ground in the center of the river. Wading birds, ducks, terns, gulls, herons and swallows were often seen in late summer and early fall resting on the mud at the edge of pools of water in the lake.

Some species of birds chose these patches of bare ground for feeding. Insects were common in those places that were moist, and most of those species of shore birds which rested on the flats also fed there. In the newly ploughed ground there was a supply of insect food, which the Franklin's gull, black tern, crow, red-winged blackbird, bronzed grackle, cowbird, robin and bluebird hunted at various times. These birds usually fed in flocks. Single birds of those species which nested near houses were frequently seen running over the bare ground of the yards, picking up nest material or food particles. A few species, such as the mourning dove, bobwhite, prairie horned lark, and blue jay habitually fed in the bare parts of the roads in the vicinity.

CUT BANKS.

Cut banks were found along some parts of the roads, where they had been cut by road graders; along the edges of the river; and along the creek. The cuts along the creek were the largest, some of them being over fifty feet high. These high banks were cut through deposits of lœss, and so it was possible for them to be almost vertical.

Birds used these vertical banks chiefly as nest locations. The belted kingfisher, bank swallow and rough-winged swallow nested in holes of their own excavation. Phœbes and Carolina wrens built their nests in shallow cavities in some of the banks.

A few birds used the crevices and nooks of the cuts as roosting places.

OPEN WATER.

An account of the extent and character of the open water of this area has been given in a previous paper* Many species of aquatic birds showed a preference for this part of the habitat in their feeding and resting activities.

BUILDINGS; BRIDGES; POSTS.

An account* has been given of the number and character of the buildings and bridges of the area and of their influence upon bird life by providing suitable nest sites for several species. Nearly every field was fenced and was surrounded with a line of wooden posts. Some of these posts had cavities in which chickadees and bluebirds nested. Many passerine birds used the fence posts as perches where they rested and sang. Occasionally a bird found some insect food on a fence post.

TREES; HOLLOW STUMPS.

The dead remains of trees were found throughout the timber of the area. They were used as perches by many birds, especially those flycatching species which required an unobstructed view of the surrounding air so that they might locate approaching insects. For other birds such as the robin, cardinal, and brown thrasher, these dead branches were favorite singing perches.

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* Wilson Bulletin (vol. 40, 1928, pp. 167-177)

Most of the cavities in the trees were small, so that the birds which nested in them were chiefly limited to the smaller species such as the screech owl, the woodpecker, the titmice, the crested flycatcher, and the bluebird. Carolina wrens nested in the tops of low stumps.

ANIMALS.

Cowbirds were seen in small groups which followed herds of grazing cattle and horses in pastures in their search for food.

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Birds of a Limited Area in Eastern Kansas.

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IT IS the object of this report to set forth the significant facts and inferences which were obtained in 200 days of field work upon the environmental relations of the birds of a small area of ground chosen to typify the region of the Missouri river in Kansas. The work extended from August, 1921, until May, 1925. Unless stated otherwise, all the observations herein recorded were made within one and one-half miles of the townsite of Geary, Doniphan county, Kansas.

For each species of bird known to have occurred within the limits of this area at the time of this study an attempt is made to give concisely the facts learned which bear upon its frequency of occurrence and relative abundance; its local or habitat distribution; the factors which determine its presence and habitat distribution; and its annual cycle of activity. The area chosen proved to be an especially favorable one for such a study, because little was known of the bird life of that part of Kansas. A great variety of habitat conditions was present there, partly due to the influence of the Missouri river; and rapid changes in the habitat and their resulting effects upon the bird life could be studied.

A discussion of the habitat divisions of the area and of the general features of environmental relations of the birds has been given in the Wilson Bulletin (Vol. 40, 1928, pp. 157-177). For an account of the mammals of this area see the *Journal of Mammalogy* (Vol. 9, 1928, pp. 140-149). See Copeia (No. 164, 1927, pp. 75-82), for a brief treatment of the amphibians and reptiles of the area.

DISCUSSION OF SPECIES.

Podilymbus podiceps (Linnæus).

Pied-billed Grebe. (5.5.)*

The pied-billed grebe was generally found feeding and resting in the open water of the lake, although on two occasions birds of this species were seen among scattered growths of *Typha*. Usually a single bird was seen; the largest number found together at one time being three. Two different times grebes were found in flocks of coot.

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* Numbers in parentheses are percentages of frequence, which were obtained by dividing the number of days on which the species was recorded by the total number of days on which observations were made.

This bird was found in spring from April 21 until May 13, and in the fall from August 25 until November 18.

Larus argentatus Pontoppidan.

Herring Gull. (8)

During the migrations this gull stopped to feed in the shallow water and on the mud at the edge of the lake. It was often seen resting on small sand bars in the river, on the ice of the lake, or on the mud at the edge of the lake.

In early spring this bird was usually seen singly or in small groups. About fifty were standing in the shallow water of the lake on April 1, 1923. A flock of about twenty-five came in and stopped, balancing themselves with outstretched wings for a moment after lighting. On the afternoon of April 6, 1923, a loose flock was seen flying down the river near the west bank. When flying, these birds almost always kept over the water.

The first record for this bird in 1923 is February 18. The first 1924 record is February 22. The latest spring record is May 3, 1924.

Larus delawarensis Ord.

Ringed-billed Gull. (3.5.)

A few of these birds were flying over the lake or standing in the shallow water on April 14, 15 and 26, 1923. On June 10 and 12, 1923, one stayed at the edge of a small pool in the center of the lake bed. A bird in immature plumage was shot on the river by duck hunters on November 3, 1923. This bird was given to the museum of the University of Kansas.

Larus franklini Richardson.

Franklin's Gull. (2.5.)

Large flocks of Franklin's gull were feeding in long lines back of plows in fields near the river on May 9 and 17, 1924. Several flocks were flying north over the lake on April 21 and May 18, 1924. On this late date they flew so high that they were almost out of sight, and they called as they flew over. Duck hunters shot one out of a flock on the river on September 16, 1923.

Larus philadelphia (Ord.).

Bonaparte's Gull. (5.)

Duck hunters shot two Bonaparte's gulls in a small flock that was flying down the river early in the morning of November 9, 1924.

Sterna forsteri Nuttal.

Forster's Tern. (2.)

Two males were collected from a flock that was feeding over Roundy lake on August 25, 1921. The terns were still numerous on the lake on August 27.

A small flock of Forster's terns was resting on a wire fence and in the shallow water at the edge of Doniphan lake on May 4, 1924.

Sterna antillarum (Lesson).

Least Tern (21)

A few of these birds were present during the early part of each summer. Throughout August of 1922 they were seen daily, but in August of 1923 only a few were seen.

Least terns were most often seen feeding at small pools cut off from the river, over the river, or over the lake. Several were watched that were feeding over the lake on August 9, 1922. They were securing small fish about two inches long, by diving from a height of about fifteen feet, and they were carrying them toward the river. Single birds arrived and left at frequent intervals.

On August 14, young terns appeared at the lake and attempted to catch fish. The adults were busy feeding the young. While being fed each young tern settled on the surface of the water and the adult approached and gave it food, but did not itself alight. Adults fed young as late as August 23.

When young birds were numerous during the last part of August, they were often seen sitting on the mud at the edge of the lake and among the feeding sandpipers.

From the direction that adults carried food from the lake, it was suspected that they had nests on some of the sandbars of the river in the summer of 1922, and that the nests were chiefly east of the lake. There was little evidence that they nested in the vicinity in the summer of 1923.

There was little tendency for these birds to form compact flocks except when resting on the mud.

The earliest summer record is June 4, 1923, when two or three were circling over the river and catching fish. In 1922, this tern was last seen on September 7; in 1923, September 4 is the latest record.

Chlidonias nigra surinamensis (Gmelin).

Black Tern. (15.)

Usually, not more than half a dozen black terns were seen in one day. The largest number seen in one day was on June 3, 1923, when over one hundred were flying over the edge of Doniphan lake.

These birds were less restrictive in their choice of feeding grounds than were the other species of terns. They fed over the river, over the lake, on the mud at the edge of the lake, and once (May 17, 1924) they were seen following a plow in a field south of the lake and picking insects from the ground.

The black terns used logs, fence posts, and the mud around the lake for resting places. Sometimes they flew over the water and stayed within two feet of the surface and at other times they flew very high. Several times terns were seen sailing over the water with set wings.

The earliest date of occurrence in the spring is May 3, 1924. One was seen in immature plumage on June 23, 1922. As late as June 28, 1923, several were seen flying over the lake. In the fall of 1922 they were seen from August 9 until September 7. The only fall record for 1923 is August 25, when three were feeding over a pool along the river. The only 1924 fall record is for September 3, when one was seen feeding over the lake.

Phalacrocorax auritus auritus (Lesson).

Double-crested Cormorant. (1.)

Two double-crested cormorants were swimming in Doniphan lake on May 8, 1924, and one on May 18, 1924.

Pelecanus erythrorhynchos Gmelin.

White Pelican. (5.)

A flock of pelicans was seen resting on a sand bar in the river on April 21, 1924. On May 8, 9 and 10, 1924, a small flock was seen which was in almost the same place in the river each day. The birds were standing in the water and close together. Another flock was noted on a sand bar in the river on May 17, 1924. A flock was seen circling and flying north over the bluffs on April 8, 1923.

Pelicans were seen flying south in the fall on September 10 and 24, and October 7, 1922, and on September 10, 1923.

Mergus americanus Cassin.

Merganser. (3.5.)

The merganser was generally seen in pairs, swimming in the icy water of the river, although on two occasions it was seen on the lake. A female was shot on the river on November 18, 1922, by Mr. Frank Whittaker. This is the earliest fall record. March 3, 1923, when several pairs were feeding on the lake, is the latest spring record.

Mergus serrator Linnæus.

Red-breasted Merganser. (5.)

Two red-breasted mergansers were killed on the river by duck hunters on November 17, 1923. The head of one of them was examined and preserved and is now in the collection of the University of Kansas.

Anas platyrhynchos Linnæus.

Mallard. (23.5.)

The number of mallards present on the area varied from a few, to several thousand, depending upon the time of year and the favorableness of the season.

On December 2, 1922, a male was flushed from beneath a small bush that was hanging over the water on the creek one-half mile above the bridge. It rose from the water and flew a few feet, where it settled on a small pool. It repeatedly dived and swam back and forth for nearly half an hour until it was killed just before dark.

Mallards were seen feeding at various times on the lake, on the creek, in pools on the bar, and on the river.

On June 12, 1922, three were flushed on the north side of the lake that may have been young, just able to fly. They were in a small pond that was cut off from the rest of the lake.

The flocks that were on the lake on February 22, 1924, were divided into pairs. Throughout the spring the pairs of Mallard on the lake appeared to stay together. Most of the small flocks that were seen in the summer were made up entirely of males.

In the spring migrations of both 1923 and 1924 the largest number of mallards was seen during March. This bird was seen as late as June 7, 1923, and May 17, 1924.

On March 15, 1924, a flock that was flying up the edge of the river valley turned when it came to the creek and flew up the creek valley as far as it could be seen.

Anas rubripes Brewster.

Black Duck. (1.5.)

Duck hunters killed a female on the river, two miles south, on November 3, 1923. Another was killed at the same place on the next day. Several were reported killed on the lake, earlier in the season. The three that were examined had feet of the same color as those of the mallard.

Chaulelasmus streperus (Linnæus).

Gadwall. (1.)

Duck hunters killed a female on the lake on November 4, 1923. On March 29, 1924, three were feeding in the northwest part of the lake.

Mareca americana (Gmelin).

Baldpate. (1.)

One was killed on the river by hunters on October 27, 1922. Another was seen swimming with mallards in a small pool near the bluff and north of the lake, on March 29, 1924.

Nettion carolinense (Gmelin).

Green-winged Teal. (6.)

The green-winged teal fed in the shallow water at the edges of the lake during the migration seasons. It was generally present in small flocks.

The earliest spring record for this duck is March 3, 1923, and the latest spring record is April 21, 1924. Some were killed on the lake on October 29, 1923, and November 29, 1924.

Querquedula discors (Linnæus).

Blue-winged Teal. (21.5.)

The blue-winged teal was one of the most common ducks during the seasons of migration. During each season it was found in small flocks that stayed to feed on the lake and on the sloughs on the bar. On the lake it fed in the shallow water, on the mud around the edge, and in the growth of *Typha*. On September 12, 1923, several single birds were flushed from the large patch of *Polygonum* that was growing in the lake.

After the middle of April, flocks of this bird tended to break up into pairs.

This duck was found from April 2 until June 2, 1923, and from April 5 until May 30, 1924. In the fall it was one of the first ducks to arrive. It was present in the fall of 1922 from August 21, when a flock of about twenty was feeding on the lake, until October 29. In 1923 it was observed as late as November 18.

Spatula clypeata (Linnæus).

Shoveler. (11.)

The shoveler was usually seen in small numbers feeding in the shallow water at the edge of the lake or on the mud nearby. On March 3, 1923, several pairs were feeding on the lake in water deep enough that they had to tip to reach the bottom.

All of this species that were seen in the spring were segregated into pairs of male and female. The shoveler was present from March 3 until May 13, 1923, and from March 29 until May 30, 1924. It was recorded on November 7 and 9, 1924.

Dafila acuta tzitzihoa (Vieillot).

American Pintail (12)

Pintail stopped in large numbers to feed in the shallow water of the lake. Often when the lake was covered with ice in the spring, flocks of this duck were seen standing on the ice, as on March 15, 1924. There was some open water in the lake at this time.

On the morning of February 22, 1924, there were several hundred on the lake, and they kept coming in in small flocks. These flocks tended to break up into pairs consisting of a male and a female. There was often as many as a dozen pairs in the air at one time. In the flight, the male generally followed the female.

The dates of occurrence in the spring are between January 29 and June 3, 1923, and between February 22 and May 3, 1924. Fall records are September 24 and October 29, 1922.

Aix sponsa (Linnæus).

Wood Duck. (12.5)

The wood duck was seen more often and in greater numbers in 1921 and 1922 than in 1923 and 1924. During August, 1922, small groups were often seen flying down the river in the evening. At other times they were feeding in small groups or singly in the weeds or patches of *Nelumbo* in the lake.

A large flock was seen on the lake from August 25 to 27, 1921. On June 14, 1922, a group of six, that was flying over the lake, settled on the water. From August 5 until September 24, 1922, small flocks were seen frequently on the lake and on the river.

Dates on which this duck was found in 1923 are August 23 and September 5, 8 and 12. On October 11, 1924, a small flock was seen on the lake.

Marila americana (Eyton).

Redhead. (5.)

On the afternoon of April 21, 1924, a pair of redheads was swimming alone on the lake. Later they joined a small flock of *Marila affinis*. These birds were tame and allowed a close approach.

Marila affinis (Eyton).

Lesser Scaup Duck. (6.5.)

A female lesser scaup duck that was shot on April 7, 1923, on a pool below a spring, had its stomach filled with shells of small snails. These birds were usually found in small flocks on the lake. They were most often found in the deeper parts of the lake, although at times they were found in the shallow water. One was killed on the river on November 17, 1923.

Dates of migration are between April 7 and June 3, 1923; November 4 and 17, 1923; and February 22 and May 29, 1924.

Marila collaris (Donovan).

Ring-necked Duck (.5)

Hunters killed a ring-necked duck on the lake on November 17, 1923.

Chen hyperboreus hyperboreus (Pallas).

Snow Goose. (.5)

A flock of about thirty birds that was flying down the river in a loose, irregular line on March 3, 1923, was identified as belonging to this form.

Branta canadensis canadensis (Linnæus).

Canada Goose. (3.)

March 3, 1923, three large flocks were seen on the river. One flock of about one hundred and fifty settled on a large sand bar in the river. April 2, 1923, ten birds were seen flying up the river in a loose line. They flew very fast with the strong wind. On February 3, 1924, a flock of 23 was seen flying northwest up the creek valley. On March 1, 1924, a small flock was flying northwest early in the morning. Some were heard calling overhead at night on March 28, 1924.

A flock of twenty-five stayed in the vicinity for nearly a week in the middle of March, 1925. They stayed on sand bars in the river during the day and just before dark they flew out each evening to a large wheat field on a hill where they stayed until morning, when they returned to the river.

A flock was flying down the river on November 9, 1924.

Botaurus lentiginosus (Montagu).

Bittern. (4.)

Single birds of this species were flushed from patches of *Polygonum*, *Nelumbo*, and other plants at the edge of the lake on September 4 and 10, 1922, September 8 and 12, 1923, and October 6, 1923.

Ixobrychus exilis (Gmelin).

Least Bittern. (1.5.)

A least bittern was flushed from a small patch of *Typha* in the south part of the lake in the middle of the forenoon of June 13, 1922. On August 12, 1922, one was shot at six o'clock in the morning. It was perched on a stem of *Typha* and about eight inches from the water. Several were flushed from patches of *Typha* in shallow water in the north part of the lake on May 30, 1924.

Ardea herodias herodias Linnæus.

Great Blue Heron. (39.5)

Great blue herons were often seen standing in the water or feeding at the lake. They were found in patches of *Typha, Polygonum, Nelumbo*, as well as in the open water and on the mud flats. They were sometimes seen on sand bars in the river or at the edges of pools that were cut off from the river. A few times in late summer they were found feeding along the creek.

Usually not more than six of these birds were seen in a single day.

Although individuals of this heron were present during the entire summer, they were not found actually nesting. On May 6, 1923, three single birds of this species were seen flying to the river from a westerly direction over the bluff. They arrived about ten minutes apart, and may have been from some nesting ground.

On March 30, 1923, one was seen in the center of the lake at sunrise and another was feeding in the water there at about ten o'clock in the morning. The water was about eight inches deep. The bird flew a short distance, and after alighting it reached into the water for a fish which it swallowed. The swallowing was accompanied by rather violent jerks of the neck. After a few minutes the bird moved and captured another small fish. This fish was thrown into the air and caught three or four times and then swallowed head first. The heron left after about ten minutes.

The latest fall record for this bird is October 29, 1922. The earliest spring record is March 29, 1924. In 1923 it was first seen on March 30.

This heron was often heard calling on the lake, especially in late summer and early fall.

Florida cœrulea (Linnæus).

Little Blue Heron. (1.)

On September 2, 1924, a single little blue heron in white plumage was feeding on the mud and in the shallow water at the edge of Doniphan lake, and on September 3 a loose flock of twelve, in the white plumage, was seen at the edge of Roundy lake.

Butorides virescens virescens (Linnæus).

Green Heron. (36.5)

As a rule, only one or two green herons were seen in one day, but in August and early September they were more numerous, and groups of twelve or more birds were often seen. One such a group was seen that was in water about three inches deep in the lake on August 14, 1922. Some were wading in the edge of the *Typha* and were even climbing among the stems of that plant. The birds squawked as they moved about. When a shotgun was fired nearby the birds did not fly, and they appeared to be not disturbed. Sometimes these herons rested on the mud at the edge of the water, sometimes on the piles of drift along the river or the creek, and sometimes in the willow and cottonwood trees on the bar.

This heron fed at the edge of the lake, often in patches of the various kinds of vegetation along the creek, along the river, and in pools on the bar.

The only nest that was seen of this species was found on June 5, 1923. It was in the top of a small cottonwood on the bar near the mouth of the creek. It was about one hundred yards from the river. The nest was near the main trunk of the tree and was about twenty feet from the ground. There were eggs in the nest, but the number was not determined. The sitting bird left when the nest was approached and returned in about fifteen minutes. The weeds that were growing beneath the nest were covered with white excreta of this species.

April 28, 1923, is the earliest date on which this bird was recorded in spring, and September 24, 1922, is the latest date of its recorded presence in the fall.

Nycticorax nycticorax nævius (Boddært).

Black-crowned Night Heron. (7.5.)

This heron was flushed from the tops of cottonwoods along the river and from the exposed mudflats around the edges of the lake. It was found in trees more often than were the other herons, and when flying it was usually at higher altitudes than were the others. It appeared to be more wild than the others, and it squawked more than they did.

Several were seen on the lake on August 25, 1921. On June 19, 1922, four in immature plumage flew from some *Typha* at the edge of the lake to the trees near by. In the fall of 1922 this species was seen on August 11, 23 and 31, and September 4, 7 and 10. In 1923 it was found on May 13 and June 5, 6 and 10. In 1924 it was found on April 21 and May 30.

This bird was usually present in small, compact flocks of fewer than eight individuals.

Rallus virginianus Linnæus.

Virginia Rail (1.5)

On September 10, 1923, a female of this species was found in a weedy pasture. It had been crippled, but was able to run. There was a telephone wire on the north side of the pasture which the bird may have hit in its migration flight. On September 3, 1924. one was flushed that was in *Typha* at the edge of the lake.

Porzana carolina (Linnæus).

Sora. (4)

Soras were flushed in *Typha* and *Nelumbo* at the edge of the lake. Dates of occurrence in spring are between May 8 and 17, and in the fall between August 28 and September 12.

Fulica americana Gmelin.

Coot. (16.5.)

The number of coot present at one time varied from a few to several hundred. This species was found in the open water of the lake, on the mud at the edge, and in the *Nelumbo* and *Typha*. Usually the flocks were not very compact. When the birds were feeding they often dived and picked up food from the bottom. A large flock that was feeding on the mud at the edge of the lake on May 17, 1924, ran into the water when it was approached.

In the spring these birds were often heard calling, and they were rather tame. In the fall, when many were shot by duck hunters, they became very wild and hard to approach.

In 1922 a group of seven was present on the lake as late as June 19, when they were seen swimming in the edges of patches of *Typha*.

April 4, 1924 is the earliest spring record for this species, and November 30, 1923, is the latest date of its recorded occurrence in the fall. The earliest fall record is September 6, 1923.

Steganopus tricolor Vieillot.

Wilson's Phalarope. (15.)

A few individuals of this species were feeding with the sandpipers at the edge of Doniphan lake on May 11, 13 and 20, 1923, and on May 8, 1924.

Gallinago delicata (Ord.)

Wilson's Snipe (5.)

This bird was found in small numbers, usually less than four, and it preferred those portions of the lake shore that were grown up with vegetation. It was also found at the edges of pools on the bar below springs and along sloughs.

Spring records are between April 2, 1923, and May 8, 1924. Fall dates of occurrence are October 29, 1922, and November 8, 1924. when one was seen at the edge of a pool in the creek.

Limnodromus griseus scolopaceus (Say).

Long-billed Dowitcher. (1)

A single bird was feeding at the edge of the lake on September 4, 1922. Two birds at the edge of Doniphan lake on May 18, 1924, were approached to within fifty feet.

Micropalama himantopus (Bonaparte).

Stilt Sandpiper. (5.)

One shot out of a small flock in the shallow water at the edge of Doniphan lake on May 18, 1924.

Pisobia maculata (Vieillot).

Pectoral Sandpiper. (18)

The pectoral sandpiper was found in flocks which varied in size from one or two birds up to several hundred and which fed in the shallow water and on the mud at the edge of the lake.

In the spring of 1923 this sandpiper was present from March 30 until June 7. In the fall of 1922 it was present from August 10 until October 8.

Pisobia fuscicollis (Vieillot).

White-rumped Sandpiper. (3.)

This bird was feeding with other sandpipers at the edge of the lake on August 22, 28 and 31, and September 7, 1922; June 7, 1923; and May 18, 1924.

Pisobia minutilla (Vieillot).

Least Sandpiper. (13.5.)

This sandpiper fed on the mud around the lake in larger numbers than any of the other species of sandpipers. Records of its occurrence in spring are between May 3, 1924, and June 7, 1923. In the fall of 1922 it was present between August 9 and September 10.

Ereunetes pusillus (Linnæus).

Semipalmated Sandpiper. (4.)

The semipalmated sandpiper was found in about the same places and at about the same time as the least sandpiper.

Limosa hæmastica (Linnæus).

Hudsonian Godwit. (1.)

On May 13, 1923, a flock of nine was wading along the west side of Doniphan lake in water about four inches deep. Another that was crippled stayed by itself on the mud, but not in the water. When it was approached to within ten yards it would fly out over the water and sail back to shore. A small pool of blood was left after each stop. Once it squatted on the ground until it was approached closely. The flock separated at one time and a part flew a short distance along the edge of the lake.

On May 17, 1924, two stopped with other shore birds on the north edge of the lake.

Totanus melanoleucus (Gmelin).

Greater Yellowlegs. (2.)

The greater yellowlegs was found on the lake on September 4 and 7, 1922; April 14, 1923; and April 21, 1923. Only a few individuals were seen at each time.

Totanus flavipes (Gmelin).

Yellowlegs. (185.)

In the spring and fall the yellowlegs fed at the lake both in the shallow water and on the mud at the edge. On April 21, 1924, some were seen feeding on the mudflats along the river.

On April 28, 1923, these birds made much more noise and were much more restless than they had been two weeks before.

On August 14, 1922, a large flock flew to the lake and settled at about six o'clock in the evening.

Usually several small flocks fed at the lake at one time. On March 30, 1923, the earliest spring record was made, and the latest spring record was made on June 3, 1923. In the fall this bird was seen between August 10, 1922, and October 11, 1924. None was seen in the fall of 1923.

Tringa solitaria solitaria Wilson.

Solitary Sandpiper. (8.)

Although not so many individuals of this species were noted as of the other species of sandpipers, they were found in a greater variety of situations. Usually single birds were found. They were most often found at the edge of the lake. On August 2, 1922, one was feeding along the creek above the bridge. It flew down the creek when it was disturbed. On September 4, 1922, one was feeding at the edge of a *Nelumbo* patch at the edge of the lake. One was flushed at the edge of a small opening in *Typha* on August 21, 1923. One was seen on the mud at the edge of a pool cut off from the river, near the mouth of the creek, on September 8, 1923. Two were seen at a marshy place below a spring on April 28, 1923. May 17, 1924, is the latest recorded date of occurrence in the spring.

Catoptrophorus semipalmatus semipalmatus (Gmelin).

Willet. (1.)

A male flew to the lake at five o'clock on the afternoon of August 22, 1922, and settled in water about three inches deep. The bird was shot after it had started to bathe. It permitted a close enough approach to be shot with No. 10 shot.

On May 18, 1924, a crippled willet was seen on the mud at the edge of Doniphan lake. It would not allow a close approach, but it staggered when it attempted to run or to start flight. It flew out over the water and returned to the shore several times.

Tryngites subruficollis (Vieillot).

Buff-breasted Sandpiper. (.5.)

On August 27, 1921, two birds of this species were shot out of a group of four at the edge of Doniphan lake. They were feeding farther away from the water than were the other kinds of sandpipers. Both the birds that were collected were males.

Actitis macularia (Linnæus).

Spotted Sandpiper. (18.5.)

This sandpiper fed along the creek, along the river, at the edges of pools on the bar, and among patches of *Nelumbo*. Individuals were frequently seen resting on boxes and logs in the lake. On August 23, 1921, some were seen feeding on the tops of leaves of *Nelumbo* that were floating in the lake. Spotted sandpipers were found throughout the summer, although they were more plentiful during the migration seasons. The earliest record is May 3, 1924, and the latest fall record is September 10, 1922.

Numenius americanus Bechstein.

Long-billed Curlew. (.5.)

A long-billed curlew was seen with sandpipers at the edge of Doniphan lake on May 8, 1924.

Squatarola squatarola cynosuræ Thayer and Bangs.

American Black-bellied Plover. (2.5.)

An adult came to the lake on August 21, 1922. It ran through water about two inches deep with a peculiar jerking motion. It called several times and flew away towards the river with some yellowlegs. On August 23 one was seen in about the same place. On August 28 three were feeding on the north side of the lake. About half the time they were on the shore about fifty yards from the water and the remainder of the time they were in water about three inches deep. They were very shy and it was difficult to approach them. After about three hours of stalking one was killed. The two remaining birds left in the direction of the river. Two birds were seen at the lake on August 31 which were very shy.

One was seen in water three inches deep at the edge of Doniphan lake on June 3, 1923. It did not fly far when it was disturbed, and it called only once or twice.

Oxyechus vociferus (Linnæus).

Killdeer. (16.)

The killdeer was often seen, with other waders, feeding on the mud around the lake. These birds usually kept a little farther back from the water than did the other waders. The groups of killdeer were usually not large, the largest flocks being found in the fall and being composed of about twelve birds.

Spring records for this bird are between March 15 and June 23. Fall records are between August 13 and October 30.

Charadrius semipalmatus Bonaparte.

Semipalmated Plover. (7.)

This bird was found feeding around the edges of the lake, both near the edge of the water and at a little distance back from the shore.

Dates of occurrence in the spring are between May 3, 1924, and June 7, 1923. Fall migration dates are between August 11, 1922, and September 7, 1922. This bird was not seen during the fall in other years.

Colinus virginianus virginianus (Linnæus.)

Bobwhite. (17.5)

The bobwhite was not numerous. Never were more than one covey or one or two pairs seen in a single day, and although the bird was probably present throughout the year, none was seen in November or February.

This bird fed in weed patches and deserted fields along the sides of the hills, along the roads, and in the timber on the bluff. Sometimes it was found in the willows on the bar. In the mornings it was often heard calling along the creek or on the bar, and more frequently between May and September than at any other time.

A pair was flushed from an unfinished nest on June 10, 1922. The nest was in a heavy growth of grass on the side of a ravine on the bluff. The nest was nearly finished and opened to the south.

All of this species that were seen between the first of October and the first of May were in coveys that were made up of from eight to twenty birds. During the rest of the year individuals or pairs were seen, and these were most often noted along the roadsides.

Zenaidura macroura carolinensis (Linnæus).

Mourning Dove. (845.)

Several mourning doves were seen daily throughout the year except during the winter, when they were present in much smaller numbers. They fed in all parts of the area where they could find food. Most of their food was obtained from the ground or from plants that produced seeds near the ground. The mourning dove was often seen gleaning food from the roads, from barn lots, from weed patches, from pastures, from mud flats near the lake, from granaries, from fields, and from open places both on the bluff and on the bar. Mourning doves rested upon dead or leafless limbs of trees, on buildings and bridges, and on telephone wires. When moving from one place to another these birds were often seen flying high above the tops of the trees.

On April 22, 1924, a pair was seen building a nest in an Osage orange tree along a road east of the center of the area. On May 3, 1924, an adult was brooding an egg in a nest ten feet from the ground on a horizontal limb of a box elder that was in a yard.

A pair was watched that was working on a nest at eight a. m on May 6, 1923. The nest was in a tree in a yard, and was on a horizontal limb twelve feet from the ground. The female stayed on the nest while the male made trips to the ground in the edge of an orchard about fifty feet away to get material. Each trip required from ten to sixty seconds. When returning to the nest with material the bird did not fly directly to the nest, but first stopped in some other part of the tree usually at the end of a dead limb and about ten feet from the nest. After about ten seconds it would fly to within one foot of the nest. Instead of lighting directly on the nest the bird usually settled on the back of its mate and then lowered its head, bringing the material for the nest near to and below the head of the female. The female then took the straw or sticks in her bill and arranged them in the nest. She turned after each trip so that the nest was built evenly all the way round. A few times the male laid the material directly on the nest. He always left immediately after the female took the sticks. No trace of this nest could be found on May 13.

On May 19, 1923, a pair was building a nest twelve feet from the ground in an Osage orange along a road. One bird was on the nest and one carried material. The same pair was working on this nest on the next day.

A nest containing two eggs was found in an apple tree in an orchard on June 7, 1923. It was twelve feet from the ground. As the brooding adult left the nest it flew low but did not touch the ground.

An adult was brooding on a nest fifteen feet from the ground in an elm tree on June 8, 1922.

A mourning dove was seen on a nest with two eggs that was on a leaning willow stump in the north part of the lake on June 19, 1922. The nest was two feet above the water and about one hundred yards from the shore. Whether or not the young were successful in reaching shore was not determined.

A partially completed nest was found nine feet from the ground on the main trunk of a redbud that was leaning at a forty-five degree angle. The tree was on the lower part of the bluff. An adult was on the nest, but it flew to a small limb near the ground and about fifteen feet away when it was approached.

An adult was brooding on a nest twenty-two feet from the ground and four feet from the end of a limb of a walnut in a yard on June 23, 1923. On June 26 another adult was found brooding on a nest forty-five feet from the ground and near the end of a branch of a honey locust that was twenty-five yards from the walnut.

A single adult was gathering material from the ground in a yard and carrying it to a limb eleven feet from the ground in a peach tree in an orchard in the morning of June 24, 1923. The same bird was carrying material and working on this nest on June 26.

A nest was found thirty feet from the ground and four feet from the end of a limb of a large elm along a road on June 30, 1923. An adult was brooding at 7:30 a. m., and another adult was perched on a limb three feet away.

On July 1, 1923, a nest was seen in a maple in a yard, which also contained nests of the blue jay and the Baltimore oriole. This nest was thirty feet from the ground, and was on a limb that was nearly forty-five degrees from the horizontal.

The latest nest record for this species is July 18, 1923, when a nest was found that was thirty feet from the ground and three feet from the main trunk of a hackberry in the E. V. Roundy yard. An adult was brooding.

These birds were often found in groups of three, especially in early fall. Larger flocks were noted in late summer, as when several small flocks were seen along a road on August 28, 1923. On August 29, 1923, some flocks were feeding in the wheat stubble on the hills north of the lake. Occasionally, during the winter, flocks numbering from twelve to fifteen were found feeding in weed patches along the edge of the bar or along the creek in sheltered places.

Cathartes aura septentrionalis Wied.

Turkey Vulture. (38.)

From one to twelve turkey vultures were seen almost daily in the summer, soaring over the bluffs or over the river valley. They were not often seen except when flying. Once one was seen resting on some drift on a sand bar in the river. At one time one was seen perched in a cottonwood tree on the bar, and on another occasion one was seen in the top of a medium sized dead tree near the top of the bluff.

On June 6, 1923, a nest was found in a hole in the top ledge of limestone of the bluff and three-fourths of a mile south of the center of the area. The hole was two feet across at the opening and was ten feet deep. Its floor sloped down at an angle of about forty-five degrees from the horizontal. The opening was shaded by small shrubs and larger trees. In the morning when the nest was found the brooding adult scrambled back to the far corner of the hole. It was too dark in the hole to distinguish objects in the nest. In the afternoon when a flashlight was used the adult refused to leave the nest. When small pieces of rock were thrown into the hole the bird moved a little, and one young bird could be seen and apparently three eggs. These may have been parts of eggs. The shells appeared to be dark brown and no spots could be seen. The young bird was white and downy. A large amount of dark brown, semi-solid food material with a very disagreeable odor was regurgitated by the brooding bird when it was disturbed.

April 5, 1924, is the earliest spring record for the turkey vulture, and September 24, 1922, is the latest fall record.

Circus hudsonius (Linnæus).

Marsh Hawk. (12.)

Usually, only one marsh hawk was seen at one time, but pairs were seen on a few occasions. The status of this bird may be shown best by a summary of its occurrence by months.

On January 24, 1923, one was chased over the river and into the willows by a crow. One was seen on each of the three days following. On February 18, 1923, two were flushed from the thick growth of small willows between the lake and the river. They flew up the river together. One was seen flying over the bar on February 5, 1924. None was seen in May. Marsh hawks were seen flying over the bar on March 3 and 31, 1923. One or two crows were seen flying at the bird seen on the latter date. April dates are 1 in 1923, and 19 and 21 in 1924. On June 13, 1922, one was flying north over the willows in the afternoon. On June 21 a female was flying low over the willows, and on June 22 one was flushed in the tall grass between the lake and the river. There are no July records. On August 10, 1922, one that was hunting around the lake scared away a small flock of sandpipers. An adult was flying over the willows near the mouth of the creek on August 14, 1922. On August 23, 1923, one, in the reddish phase, flew low over the bar near the river. There are five records for September. On September 8, 1923, one flew low over the lake and was chased by a whole flock of swallows late in the afternoon. One flew low over the willows on October 7, 1922. There are no records for either November or December.

Accipiter velox (Wilson).

Sharp-shinned Hawk (.5)

A sharp-shinned hawk was flushed from the ground near a marshy place at the foot of the bluff on May 12, 1923. It flew into the willows on the bar, where it stopped. Another flew over the bar on February 14, 1925.

Accipiter cooperi (Bonaparte).

Cooper's Hawk (15.5)

Single Cooper's hawks when seen were usually flying over the tops of the trees on the bluff, on the bar, or low over the fields. On August 25, 1921, one was shot in a tree which stood about half way to the top of the bluff.

On June 7, 1922, a female was brooding five downy young in a nest thirty feet from the ground in a red-oak tree at the side of a road on the bluff. The nest was in a fork of the main trunk of the tree, which was six inches in diameter. While the tree was being climbed the adult made three swoops to within a few feet of my head and called several times. The next day the female was seen going to the nest at six o'clock in the evening. She was seen in a near-by tree on the 10th. On June 18 an adult circled around the nest. The white, downy feathers of the young birds could be plainly seen from the ground. A male was carrying food in the direction of the nest on June 21. On June 26 the five young, whose feathers were now about half grown, were shot out of the nest. Their stomachs were filled with the remains of two chickens of a size which would probably weigh about half a pound.

A nest was found fifteen feet from the ground in an oak tree in a ravine on the Whittaker farm on June 11, 1922. It held five bluish-green eggs. They were fresh. The female was not on the nest in the morning, but was incubating at five o'clock in the evening.

A Cooper's hawk was seen flying high over the willows on January 26, 1923. One flew into the group of trees near the house on the Whittaker farm on February 3, 1924. On April 14, 1923, one, flying west over the lake, caused a small flock of yellowlegs to rise and call, but it flew on without stopping. On April 15 one was chasing a red-tailed hawk over the bluff.

Late fall dates for this bird are November 17 and 18, 1923. One that had not been dead for a long time was found on the shore of the lake on November 30, 1922.

Buteo borealis borealis (Gmelin).

Red-tailed Hawk. (32.)

In the summer not more than one or two of this species were seen in a single day, but in winter and the seasons of migration it became more numerous, and several were often seen at one time. It was most often seen flying over the bluff and the bar. Sometimes it was found resting in the tops of tall trees. On May 10, 1924, one was flying among the trees and near the ground on the bluff. On April 15, 1923, one was chased out of the timber on the bluff by a Cooper's hawk.

A red-tailed hawk flew from a nest in a tree near the top of the hill one-quarter of a mile northeast of the E. V. Roundy house on March 31, 1923. At first the bird stopped in a nearby tree and called several times; then it moved on to other trees and finally circled overhead several times; but it did not leave the vicinity. Two hours later, when it was approached, the bird left the nest directly. The nest was twenty-five feet from the ground and was in the top of an oak tree that was one foot in diameter at the base. On April 1, when the tree was climbed, the nest contained three eggs. The female stayed nearby and called while the nest was being examined. On April 7, the nest had one whole egg with a large hole in the side and one egg with a larger hole lay on the ground. No hawks were near. The material in the nest was disarranged.

On March 20, 1925, a nest was found in the timber one-quarter of a mile north of the nest that had been found in 1923. The female called from a near-by tree, but was not seen on the nest which appeared to be nearly finished. Some new material was seen hanging over the edge.

A female was brooding on a nest in the top of a tree in the bottom of a ravine on the bluff on March 18, 1925. The bird left the nest and flew overhead and called when persons passed through the timber near the nest tree.

On June 4, 1923, two young of this species were seen with one adult in the timber on the bluff. The young birds were able to fly. The adult was calling in the vicinity.

Some individuals of this species were seen every month in the year.

Buteo lineatus lineatus (Gmelin).

Red-shouldered Hawk. (13.)

Red-shouldered hawks were more common in August and September than at other times of the year. They were seen flying over the bluff or perched in trees on the bluff or on the bar.

A female that was shot on August 16, 1922, had a small frog and parts of several large insects in its stomach. Another was taken on September 2, 1922. Its stomach was empty.

This hawk was present in other seasons of the year on May 6 and 12, 1923; July 6, 17 and 18, 1923; and November 18, 1923

Buteo swainsoni Bonaparte.

Swainson's Hawk. (.5)

Two Swainson's hawks soared over the bluff most of the afternoon of April 1, 1923.

Buteo platypterus (Vieillot).

Broad-winged Hawk. (8)

The few records of this species are between April 21, 1924, and May 10, 1924, and between August 5, 1923, and September 1, 1923. It was usually found resting in trees on the bar or along the lower part of the bluff.

Archibuteo lagopus sancti-johannis (Gmelin).

Rough-legged Hawk. (1.5.)

A rough-legged hawk was watched feeding over a field. It was flying from one hundred to one hundred and fifty feet above the ground, and was frequently poising. Once it dropped straight to the ground, but rose again in a few seconds.

On October 21, 1923, one was circling high over the bar. On December 1, 1922, one was perched in the top of a tree in a small patch of timber on a hill one-half mile west of the bluff.

Haliæëtus leucocephalus leucocephalus (Linnæus).

Bald Eagle. (2.)

On January 29, 1923, crows chased a bald eagle over the bluff toward the lake where it stopped in a tree. Crows flew after one on February 17 and 18, 1923. On March 3, 1923, calling crows surrounded two that were in a tree on top of the bluff near the lake. The eagles flew short distances along the bluff, but they were always followed by the crows.

Cerchneis sparveria sparveria (Linnæus).

Sparrow Hawk. (1.5.)

An immature bird of this species was shot from the top of a small tree on the Whittaker farm on September 5, 1922. On September 10, 1923, one was seen on the telephone wires along the road two miles west of the river. On September 1, 1924, one was seen along the road one mile west of the river.

Pandion haliæëtus carolinensis (Gmelin).

Osprey. (.5.)

On August 11, 1922, one was flying high over the lake. It was moving south and towards the river.

Asio wilsonianus (Lesson).

Long-eared Owl. (.5.)

On March 30, 1924, a nest of this species was found twelve feet from the ground in a one-year-old crow's nest that was in a cottonwood on the bar. The tree was eight inches in diameter at the base. One owl was on the nest and another was in a willow about twenty feet away. When the bird on the nest was approached it stood up and, with spread wings, fluffed out its feathers. It flew off a distance of about twenty yards and called for a few minutes and then left. There were five fresh eggs in the nest.

Asio flammeus (Pontoppidan).

Short-eared Owl. (3.)

A scattered flock of about twenty short-eared owls was found south of the lake and about one-quarter of a mile from the river on December 2, 1922. At this point the grass was about eighteen inches high and the willow trees were scattered. Others were found at the same place on January 25 and 26, 1923, and on March 3, 1923. Pellets were collected from this place and their contents examined. They contained many skulls of *Microtus ochrogaster*, *Peromyscus* spp., *Reithrodontomys megalotis dychei*, *Mus musculus musculus*, *Cryptotis parva*, *Blarina brevicauda*, one *Cardinalis cardinalis cardinalis*, some *Agelaius phœniceus*, and some small Fringillidæ.

Strix varia varia Barton.

Barred Owl (2)

A barred owl was flushed from a tree on the lower part of the bluff northwest of the lake on October 21, 1923. It flew across a small clearing and stopped in a cottonwood on the bar, where it was watched for about fifteen minutes. About an hour later the bird was again flushed from a tree on the lower part of the bluff. One was flushed from near this place on November 4, 1923. It flew north along the lower part of the bluff The crows found the owl a few seconds after it moved and they began coming and calling.

Cryptoglaux acadica acadica (Gmelin).

Saw-whet Owl (.5)

A female saw-whet owl was shot on March 30, 1923. It was sitting on a small branch of a willow and was close to and on the southeast side of the main trunk. The branch was four feet from the ground. The tree was twenty-five yards from the lower edge of the bluff and on the bar. The bird was shot at four o'clock in the afternoon, and its stomach contained the remains of a mouse.

Otus asio asio (Linnæus).

Screech Owl (23)

The screech owl was present throughout the year, and was frequently heard calling at night

One in the gray color phase was killed in the E. V. Roundy barn in January, 1924. Another gray one was seen at a hole, ten feet from the ground, in a small tree below the road on the bluff. A group of smaller birds, that were calling, surrounded it. One was found in an old house northwest of the lake on April 14, 1923. Scattered pellets on the floor showed that the bird had been using the roost for several days. On April 22, 1924, one was flushed from a clump of roots under an overhanging creek bank. Several, which probably made up a family group, called and flew about in a yard on May 10, 1924. There were several holes in trees in the yard that probably would have been suitable nesting places for this species. On May 13, 1923, one was found perched on a leafy branch in the top of a large elm tree along a road. On May 19, one week later, one was seen on the same branch. On the afternoon of June 15, 1923, one was flushed from the center of a thicket of dogwood and grapevine along the lower edge of the bluff. On August 27, 1923, one was flushed from the top of a tree along the lower part of the bluff.

Bubo virginianus virginianus (Gmelin).

Great Horned Owl. (2.)

Although this bird should have been found, and it probably was present throughout the year, there are records for its occurrence in only seven months. A great horned owl was found sitting in an open nest, with eggs, in the spring of 1922, by Mr. Charles Regnary The bird was shot.

Coccyzus americanus americanus (Linnæus).

Yellow-billed Cuckoo. (62.5.)

The yellow-billed cuckoo, although a very common summer resident in this locality, was not seen in as large numbers as some other birds that were not so common. It is shy and solitary, and was more often heard calling than it was seen. It fed in the tops of the trees along the bluff, along the creek, and in the willows on the bar. A large number of nests was found, and accounts of some are given here to show the range in the nesting habits of this bird in this locality.

The earliest nest that was found was not complete on June 9, 1922.

On June 12, 1923, a nest was found, ten feet from the ground, on a horizontal limb of an elm tree on the lower part of the bluff near the mouth of the creek. It contained two eggs. Ten yards farther south there was another nest with two eggs, which was ten feet from the ground and in a redbud tree. This nest was more bulky than the other. An adult carried a dead leaf to the nest in the redbud. Both nests were partly shaded by larger trees. On the thirteenth the nest in the elm tree contained broken shells and there was no bird on the other nest. On this date an adult was found sitting on a nest, seven feet from the ground, in a grapevine that was growing over a horizontal limb of a small partly dead elm tree at the lower edge of the bluff. The bird left the nest, which contained two eggs, when it was approached to within ten feet.

On June 16, 1922, a nest was found, four feet from the water, in a fork of a willow among the stumps in the north part of the lake. No bird was on the nest, which contained three eggs.

An adult was flushed from a nest, with three eggs, that was seven feet from the ground in a leaning pawpaw on the side of the bluff on June 25, 1923. The bird flew to the ground when the tree was shaken.

A nest was found on June 27, 1923, which was on a horizontal fork of a lower limb of a walnut and seven feet from the ground. The tree was near the top of the bluff northwest of the lake and was ten yards from the edge of the timber. In the nest were three young birds with black quills, and one egg. An adult came about one minute after the nest was found, but after seeing an intruder, it stayed in a tree about fifty feet away and called.

On June 29, 1923, a nest was found that was six feet from the ground in a rose bush that was growing over a small walnut near the top of the bluff. An adult was brooding four eggs. When disturbed it flew to a tree fifteen feet away, and then, drooping and shaking its wings as if they were broken, it flew on farther.

On June 30, 1923, a nest was found in a box elder along a road by a cornfield. The nest was eight and one-half feet from the ground, in twigs near a horizontal limb one inch in diameter. An adult that was brooding three eggs left when the limb was shaken. Another adult that was in the tree also, left when the tree was approached to within thirty feet. On the same date a nest was found eight and one-half feet from the ground in an Osage orange tree along a road. The nest was a little to one side of a horizontal limb and was partly shaded. An adult that was brooding four eggs flew off slowly when an intruder stood near the nest.

On July 3, 1923, a nest was found five feet from the ground in an oak sprout along a road. The nest contained one egg and two young birds with black quills. The brooding adult left when it was approached to within three feet. One of the young birds opened its mouth for food. On July 9 this nest was empty and its floor was covered with scales from the young birds. Another nest was found on July 3 that was in a dogwood one hundred yards north of this one. It was five feet from the ground and contained two eggs. No bird was near. On July 9 there were four eggs but no bird was seen.

On July 14, 1923, a nest was found, four feet from the ground in a redbud six feet high, in a sprout field southeast of the lake. The nest was made of sticks and held four eggs. An adult was brooding. The sprout was surrounded by a thick growth of vegetation.

A nest five and one-half feet from the ground in a grapevine that was running over an ironwood, was found on July 15, 1923. There were five eggs in the nest. The sitting bird left when the vine was touched.

On July 18, 1923, a nest was found, four and one-half feet from the ground, in sumac in a hog pasture which was on top of a hill. An adult was on the nest which held two eggs and three young, one of which had its eyes open, one had its eyes partly opened, and one had its eyes shut. This nest was two inches deep on the outside.

A nest was found seven feet from the ground in a small willow, between the creek and a cornfield, on the bar. The nest had three eggs. The sitting adult left when approached to within fifteen feet.

An adult was sitting closely on two eggs in a nest, six feet from the ground, that was found in a rough-leaved dogwood on the bluff on August 28, 1922. On September 2 there were young in the nest. The parent stayed on the nest until it was touched, and then flew only a short distance. It appeared to be not excited. The adult was on the nest on September 6. On September 10 the nest was empty.

On September 9, 1923, an adult was brooding on a nest in the top of a medium-sized oak tree on the bluff. The nest was twenty feet from the ground.

In all, thirty nests of this species were found in the two seasons.

During the migrations, especially in the fall, this cuckoo was frequently found feeding with groups of the smaller transients. This bird was late in arriving in the spring, and was not seen before May 19 in 1923, and May 17 in 1924. In the fall the last one was seen on October 12, 1924.

Coccyzus erythrophthalmus (Wilson).

Black-billed Cuckoo. (3.)

On May 19, 1923, a black-billed cuckoo was shot from the top of a small tree on the lower part of the bluff. One was seen near the ground in the willows on June 7 and one on June 10, 1923. On June 23, 1923, one was seen along the lower part of the bluff that was carrying something in its mouth. On August 23, 1923, one was seen resting in the top of a small tree on the lower part of the bluff near the lake. It flew low over the bar about fifteen minutes later. On September 4, 1924, one was shot on the lower part of the bluff near the lake. It had part of a cicada in its mouth.

Ceryle alcyon alcyon Linnæus).

Belted Kingfisher. (25.)

Rarely were more than one or two kingfishers seen in a single day. This species was often seen feeding at the lake, along the creek, and at pools, on the bar, below springs. Its rattling cry. could usually be heard as it flew up or down the creek. On April 20, 1924, one called and stopped in a tree along the creek, where there were some holes in the bank in which it might nest.

One was seen on March 30, 1923, and one on March 29, 1924. There is a record for March 21, 1925. The latest fall record is October 8, 1922.

Dryobates villosus villosus (Linnæus).

Hairy Woodpecker. (39.5)

From one or two to half a dozen hairy woodpeckers were seen on each day that the species was observed. In the summer months they fed in the trees on the bluff, along the creek, and on the bar. During the winter months a good share of this bird's time was spent in weed patches with small seed-eating birds, where it obtained food in addition to that which it got from the trees and the tree trunks in the timber.

Two birds were making trips with food to a tree in the creek bottom on April 29, 1923. They took turns going into the hole, which was twenty feet from the ground and on the southwest side of the tree trunk. Once one waited for the arrival of the other before leaving, but usually each was in the hole for a short time only, and one did not wait for the return of the other. They made trips from 11:30 until noon.

One was feeding in a shed near the creek on February 5, 1924.

Dryobates pubescens medianus (Swainson).

Downy Woodpecker. (89.)

Several of these woodpeckers were seen almost every day that records were kept. They fed over the whole area where there was enough vegetation to insure a food supply. In the fall and winter they were nearly always prominent in the small flocks of birds that moved through the timber and the weed patches in search of food. The call note of this bird and the sound which it made in picking for food was always an indicator that a feeding flock of birds was near.

On January 28, 1923, one was seen going to roost in a hole in a tree, growing in a yard, at five o'clock in the afternoon. It flew out after the limb was struck several times with a gas pipe.

One was digging a hole in a large elm at the side of a road on May 4, 1924. On May 12, 1924, a pair was seen on a dead willow along the creek. The female was working on a nest, twenty-five feet from the ground and on the southeast side of the trunk. The male approached the female, and both flew to a near-by tree where mating took place, and the female returned to work at the nest. On May 19 one of the pair entered the nest three times within half an hour.

Young birds called loudly in a nest, eight feet from the ground in an apple tree, in an orchard on June 3, 1923. An adult was seen carrying food to them. On June 4 a bird flew out of a hole in an apple tree thirty-six steps away from this nest. On this date a nest was found in a dead stump in the bottom of a ravine which contained young. The nest hole was fifteen feet from the ground. Both parents came and called very nervously in the vicinity.

A nest was found on June 7, 1923, that was seven feet from the ground in a willow stump on the north side of the lake. Young birds inside the stump called loudly, and the parents called excitedly from near-by stumps. The young were still in the nest on June 12.

A group, probably made up of the birds of one family, was found feeding along the bluff as early as June 26, 1923.

Sphyrapicus varius varius (Linnæus).

Yellow-bellied Sapsucker. (.5.)

One that was watched, that was feeding on a tree trunk on the bluff on March 18, 1925, flew after other birds, especially woodpeckers, that came near.

Melanerpes erythrocephalus (Linnæus).

Red-headed Woodpecker. (65.5.)

Red-headed woodpeckers were more restricted in their local distribution than were the other species of woodpeckers, and so they were present in fewer numbers than were the other species. In summer they were found feeding in the larger, leafy and dead or dying trees. In winter the few that were present lived chiefly on acorns, which were produced in abundance in this area. One that was killed on the Whittaker farm on October 24, 1924, was carrying acorns. These woodpeckers were often found in the large dead trees at the edges of openings in the timber. These trees were used as perches from which the birds made short flights into the air to catch flying insects. One was seen taking corn from a crib on July 1, 1923. This species was commonly found on telephone poles along the roads.

An adult was flushed from a hole in a dead tree along a road on June 6, 1923. On June 8 a pair was feeding young birds in a hole in another tree. The parents were feeding young in this nest on June 28 and 30. On July 9 they were feeding their young in a tree across the road from the nest. On July 11 these young were seen as far as two hundred yards from the nest tree. On August 21, 1922, an adult was feeding young in a nest twenty-five feet from the ground in a dead tree along a road.

The regular summer residents were present between March 21 and September 24. Dates of winter occurrence are January 24 and February 17, 1923, and October 25, 1924.

Centurus carolinus (Linnæus.)

Red-bellied Woodpecker. (65.)

This woodpecker was found in small numbers almost daily throughout the year. It was most often seen in the timber along the bluff near the creek. Yards and orchards were frequented regularly. Although most of the feeding was done in these places, the bird was seen a few times feeding in other situations. On June 8, 1923, a pair was seen gathering food from the ground in a road. On February 7, 1924, one was eating corn at a crib in a yard. One flew into a mulberry tree along the bluff on July 7, 1923, and picked off two ripe berries which it ate. It picked one of the berries while on the wing. One was feeding on dogwood berries on the lower part of the bluff on September 8, 1923.

A red-bellied woodpecker was calling, in a hole twelve feet from the ground, in a willow stump along the creek on April 21, 1924. It left when the stump was hit. On April 29, 1923, one flew to a hole in the top of a tall, dead stump on the north side of the creek. Another bird left, and for about ten minutes the arrival stayed on the side of the stump. Then it went inside and stayed, with its head out, for about ten minutes. On May 12 an adult came and entered this hole. After a few minutes another came, and the first bird left. It returned after about five minutes, and after it stuck its head into the hole the other bird left. This bird entered and remained for as long as the hole was watched—about fifteen minutes. On May 19, 1923, a parent was feeding young birds at this nest. It entered the nest hole with food three times within eight minutes. On each trip it went in a different direction to get the food. An adult was seen carrying food to this nest on June 3, 1923, and on June 8.

A parent was feeding young in a hole in a living elm in a ravine along the bluff on June 15, 1922. A family of young, just out of the nest, was being fed near there on June 21.

Parents were seen feeding young, just able to fly, on June 6, 1922, and on June 25, 1923. The last mentioned family was seen in an orchard, and was composed of birds which were able to fly, but that had trouble in getting a foothold on the limbs on which they alighted.

A red-headed woodpecker was observed to chase a red-bellied woodpecker out of a large dead tree along a road on September 4, 1923.

Colaptes auratus luteus Bangs.

Northern Flicker. (38.)

The northern flicker was present in small numbers, but it was not so numerous as to be found daily. Individuals were found feeding in the timber along the bluff, on the bar, along the creek, and in yards. A few times it was seen on the ground or on dead stumps. On September 4, 1923, one was seen going to roost in the side of a building where there was a hole, in Doniphan. The loud call note of this bird was often heard on the bluff.

One flew out of a hole, thirty feet from the ground, in a dead stump at the edge of the lake on June 10, 1923. On June 12 a bird flew out of the same stump when the base was hit with a stick. This stump was blown into the water by a storm on June 27.

Although this species was present throughout the year, it was found in greater numbers during the seasons of migration than at other times. Flocks were seen moving south in the fall. A flock of over a dozen birds was in the Roundy yard at six o'clock in the morning of September 24, 1922. On October 7, 1922, a large flock was moving in a loose formation down the river. They stopped in the cottonwoods and other trees as they moved. A flock was scattered in the tops of the trees and slowly moving south on the lower part of the bluff on October 11, 1924. On February 17, 1923, a flock of fifteen or twenty was feeding half way to the top of the bluff.

Antrostomus vociferus vociferus (Wilson).

Whippoorwill. (46.)

Birds of this species were heard calling in the timber at night during the summer. Once, May 3, 1924, one was heard calling in the daytime. This was at nine in the morning. Occasionally one or two were flushed from the ground in thick growths on the bluff. On August 26, 1921, one was shot out of a tree on the side of the bluff. It was perched crosswise on the limb which was twenty-five feet from the ground.

On June 16, 1923, two eggshells were found on the ground among growths of dogwood on the bar north of the lake.

A whippoorwill was flushed from one egg, on the ground twenty-five yards from the edge of the timber on the bluff west of the lake, on June 14, 1923. The bird flew about thirty feet and settled on the ground. Then it flew on a few feet and stopped on a limb of brush and perched, with its body parallel to the limb. It then flew in a circle toward the edge of the timber. The timber at this place was rather open underneath, there being few weeds or saplings. Elm, walnut and oak trees were growing near by. The egg was light with a few splotches. On June 21 there were two eggs. On this date the adult fluttered away when approached, moving only about two feet at a time and acting as if its wings were broken. An adult was sitting on the eggs on June 28. It flew off and went to a small piece of brush about ten yards away where it sat with dropping wings. The eggs were being incubated on July 3, nineteen days after the first one was found, but on July 6 a diligent search showed no traces of either eggs or young.

April 18, 1924, was the earliest date on which this species was heard calling, and September 10, 1923, is the latest date on which it was heard in the fall.

Chordeiles virginianus virginianus (Gmelin).

Nighthawk. (7.)

Nighthawks were found only during migrations. They were nearly always found in flocks that flew in a southwesterly direction over the lake, and fed as they moved over the water in the fall flight. Even when not flying over the lake they usually moved in the same direction, *i. e.*, southwest. In the afternoon of August 27, 1921, one was shot from a horizontal limb in a large tree in a yard. Most of the flying birds were seen in the evening or late afternoon.

The only record for spring is May 17, 1924, when one bird was seen. Fall records are between August 23 and September 23.

Chætura pelagica (Linnæus).

Chimney Swift. (59.)

Chimney swifts were seen flying over the tops of the trees on the bluff and on the bar, over the lake, and over groups of farm buildings. Only a small number was present except during the time of migration.

Young birds, nearly ready to leave the nest, were seen in a nest in a chimney in the E. V. Roundy house on July 18, 1923. The nest was eight feet below the top of the chimney. Adults were flying overhead.

April 22, 1924, is the earliest date of occurrence in the spring, and October 11, 1924, is the latest fall record.

Archilochus colubris (Linnæus).

Ruby-throated Humming Bird. 45.5.)

Humming birds were not conspicuous, and so they were not seen every day. The species became very common in late summer and during the early fall migrations. In summer this species fed at flowers in gardens and on the bluff. In the late part of the season individuals extended the territory over which they ranged, and were found often in fields and on the bar. In August and early September they spent a great part of their time on the bar, feeding at the jewelweed which blooms at that season. A part of their time was spent resting on dead limbs and flying after one another. On August 14, 1922, one was seen flying through a cornfield. One was hovering at the end of a water pipe at a spring and drinking water on September 6, 1922. Birds of this species were usually found alone, the largest group found together at one time being three. This group was seen feeding in the willows on August 10, 1922.

The short, squeaky call note of this bird was heard several times.

All the humming bird's nests that were located, except one, were on the bluff. That nest was in the creek-bottom timber.

On June 10, 1922, a nest was found saddled on a horizontal twig three-eighths of an inch in diameter at the end of a branch of a large oak tree at the side of a road. The nest was twelve feet from the ground. A female spent most of an hour on near-by twigs. On June 17 the nest was empty. On June 24 the female was sitting on the nest. On June 26 no bird was in sight and the nest, which contained two eggs, was removed by cutting the twig which supported it. On August 5 a nest was found on another twig which was two feet away from the location of the one found first. The second nest appeared to be smaller than the first one had been. No bird was near.

On June 4, 1923, a female was building a nest fifteen feet from the ground in an ironwood tree in the timber along the creek. The limb which held the nest was three-fourths of an inch in diameter. The nest was found at 2:30 p. m. The bird worked until 2:40 p. m., when it stopped and was not again seen until 3, when it resumed nest building. From twenty seconds to two minutes were required for each trip to gather material, and about twenty seconds were spent at the nest on each trip. The bird, with the new material to be added, stood at the edge of the nest and added the material to the outside of the wall and to the limb, drawing the bill from one side to the other in the process. At least a part of the nest material was gathered from trees while the bird was on the wing.

On June 18, 1923, a nest was being built twenty feet from the ground on a branch of a hickory tree that was one-fourth inch in diameter. The nest was eight feet from the main trunk. The tree was on the top shelf of the bluff. After bringing coarse material for three trips, and placing it on top and at the edge of the nest, the bird brought some finer material which it drew from the limb over the outside of and toward the edge of the nest. Then it brought more coarse material. There were a few rest periods which the bird spent on near by dead twigs. The material was gathered from near the ground and while the bird was on the wing. Another nest was found, twenty-five feet from the ground, in an oak tree on the side of the bluff on that day. A female visited it once while it was being watched.

An adult was seen brooding on a nest on a horizontal limb of an oak tree on the side of the bluff. The nest was eighteen feet from the ground and on a branch which was three-eighths of an inch in diameter. The female left the nest once to fly after a tufted titmouse that came near.

A nest was found, saddled on a triple horizontal fork of a hickory tree on the side of the bluff on July 2, 1923. A bird went to the nest once, then left and after sitting on a dead limb for a few minutes, it returned to the nest and began brooding. One brooding adult left its nest several times to chase a Kentucky warbler from the tree which held the nest.

On July 14, 1923, a nest was found twelve feet from the ground and two feet from the end of a limb of an oak tree on the bluff west of the lake. The female left the nest when it was approached, but stayed in the vicinity for several minutes.

The season of summer residence of the ruby-throated humming bird extended from May 19 until September 15, 1923. In 1922 the last bird seen was noted on September 7.

Tyrannus tyrannus (Linnæus).

Kingbird. (44.5.)

A few kingbirds were present all summer on the ground studied, but the species was much more common during the seasons of migrations. In summer this bird was found along roads, in trees at the edge of timber on the bluff, in yards, and along creeks. It fed most often in places where flying insects were abundant. On August 18, 1923, seven were feeding from the top of a dead tree at the edge of a cornfield. They singly made trips, some of them more than one hundred yards in length, over the cornfield, where they caught insects. In the latter part of August and first of September, 1923, a flock stayed in the dogwood trees along the lower part of one portion of the bluff. Here the birds fed on the ripened berries. During the fall season of migration this bird was seen daily in trees and bushes along the river, creek and lake. From these perches the birds flew out over the water to catch insects.

Kingbirds were found occasionally on telephone wires along the roads and on wire fences. On May 17, 1924 one was making feeding trips from a dead stick in a patch of *Typha* in the lake. On August 30, 1923, several were flying over the lake. They settled in the thick growth of weeds in the water. On May 8, 1924, two flocks of about ten each were seen in a field along a road.

The kingbird did not commonly nest within the limits of the area studied, but a few nests were located near by where conditions were similar to those within the area. On June 17, 1922, a nest was found twelve feet from the ground in an apple tree on the Whittaker farm. Here one adult was brooding two eggs and one was perched on the top of the tree. On June 23, 1923, two nests were found, each about twelve feet from the ground, in sycamore trees at the edge of Doniphan lake. One was on a horizontal limb and was eight feet from the main trunk, and one was in a crotch formed by a branch and the main trunk.

May 6, 1923, is the earliest spring record for this species and September 10, 1923, is the latest date of occurrence in the fall. The latest record in 1922, is September 10.

Myiarchus crinitus (Linnæus).

Crested Flycatcher. (37.5.)

A few pairs of crested flycatchers nested in the timber along the bluff each summer. They fed along the bluff, in the willows on the bar, and in the timber along the creek. They were frequently found perched in the tops of dead trees.

Although there is no actual nesting record, there is some evidence that these birds nested in holes in trees on the bluff. On June 13, 1923, a pair was watched at a stump in which there was a hole. Each in turn called and, with rapidly moving wings, hovered before the other.

The period of summer residence of this bird extended from April 29 to September 15 in 1923. In 1923 it was not found after September 4. Crested flycatchers were present in small numbers in the flocks of small transients, which fed together in the early part of the fall migrations.

Sayornis phœbe (Latham).

Phœbe. (31.)

The phœbe is rather restrictive in its choice of habitat. As there were not suitable locations for a large number, only a few pairs remained to nest in this area. These stayed in the vicinity of buildings, especially those that were not used a great deal, bridges, and a few cut banks that were suitable. Near these places, the birds perched on dead branches or other supports and waited for suitable insect food to come near.

On April 15, 1923, a pair was building a nest on top of a stringer in a hog shed. Only one bird brought material to the nest. It gathered sticks from the ground and carried them into the shed from different directions. This bird's mate stayed within one hundred yards of the nest. After four or five trips to the nest the bird flew to a near-by box elder tree to feed. It hovered near, and picked off insects from the twigs and buds. The air was too cool for many flying insects, the temperature being forty degrees. An adult was on the nest on April 28 and on May 13. On May 19 the nest was empty. A nest in this shed in the 1924 season had four eggs on May 11. A bird was near, but none was on the nest.

A nest was found four feet from the ground on a wall of rock along the creek on April 22, 1924. It contained five eggs. The rock projected out over the nest.

On April 28, 1923, a nest was found on the side of a vertical bank of loess along the creek. The lower part of the nest was composed chiefly of mud, and it was lined with moss. There were three eggs. This nest was on a level with and was five feet away from one in a similar position that had been built and used during the previous season. On May 12 there were four eggs in the 1923 nest.

A nest with three eggs was found in an old deserted house on June 5, 1923. No birds were near. A bird was brooding on June 13. On June 27 the nest was empty.

A phœbe was catching insects at a small pool in a ravine on July 10, 1923. The insects were on the surface of the pool. This was one of the hottest days of the season.

A small flock was perched in the willows, where they were catching insects over the water, in the northeast part of the lake, on August 23, 1922.

During the migrations this bird was often seen, in the tops of trees along the bluff, in flocks of other migrating birds. It was most numerous in those situations during the last part of August.

In 1923 this bird was first seen on March 30. In 1924 the earliest record is March 29. The first was seen in 1925 on March 19. The latest fall record is September 24, 1922.

Nuttallornis borealis (Swainson).

Olive-sided Flycatcher. (2)

This flycatcher was found on only four days, all of which were in the fall On August 27, 1921, one was shot out of the top of a tree on the side of the bluff. Its loud call attracted attention to the bird. On September 3, 1924, one of two young birds was shot in the top of a large dead tree in a yard. One was feeding from the top of a dead tree along a road on the bluff on September 8, 1923, and one was seen in the same kind of a location on September 11, 1923.

Myiochanes virens (Linnæus).

Wood Pewee. (47.5.)

A few individuals of the wood pewee were seen daily in the summer. They were distributed uniformly through the timber on the bluff and along the creek. They were usually seen in the tops of the larger trees. The locations of individuals of this species were most easily determined by hearing their distinctive call note.

On June 21, 1922, a nest was found on a fork of a horizontal limb of an oak tree and twenty feet from the ground. One bird was perched in the top of the tree. Another flew out from the nest, and the two flew after a blue jay and chased it from the vicinity of the nest.

A nest was found on June 25, 1923, which was near the end of a limb of a large sycamore at the edge of the bar. The nest was twenty-two feet from the ground. An adult that was on the nest left and flew to a near-by cottonwood on the bar. An adult was brooding on this nest on June 30.

A wood pewee chased a blue jay away from an oak tree on the bluff in which there was a nest twenty feet from the ground on June 28, 1923.

Adults of this species were heard calling in a sycamore tree in which there was a nest thirty feet from the ground and on a limb one-half inch in diameter which sloped upward, making an angle of more than forty-five degrees with the horizontal. The nest was fifteen feet from the main trunk and four feet from the end of the limb. It was partially shaded. No other trees were growing near the nest tree. There were downy young in the nest.

The latest record for 1922 is August 30. None were seen after August 27 in 1923. In 1923 the first was found on May 19. The first 1924 record is May 18.

Empidonax virescens (Vieillot).

Acadian Flycatcher (5)

A few pairs of this species were summer residents of the area. They were found on the lower parts of the bluff and in the ravines.

A nest was found along the lower edge of the bluff on June 14, 1922. It was hanging near the end of a branch of an elder and was five feet from the ground. There were three eggs in the nest. In the lower part of the nest, covered with some of the nest material, there was an egg of the cowbird. The eggs and the female were taken on June 15. The eggs were slightly incubated.

On June 26, 1923, a nest was found hanging in the end of a branch of an oak and six feet from the ground. The tree was on the side of a ravine, and was twenty yards from the edge of the timber near the top of the bluff. The nest was two feet from the end of the limb and fifteen feet from the main trunk of the tree. It was made almost entirely of the dried staminate flowers of oak. Some of these hung by the ends and gave the nest a ragged appearance. There were two young in the nest covered with white down. Each had feather tracts and their eyes were not yet open. One adult was brooding and another was calling from near by. The bird on the nest left when it was approached to within ten feet.

The only record for the migration season is August 29, 1922, when one was taken on the side of the bluff.

Empidonax traillii alnorum Brewster.

Alder Flycatcher. (4.5.)

One was found in the willows north of Doniphan lake on June 7, 1921. Dates on which this bird was taken are August 22, 1921; August 25, 1922; August 21, 1921; August 31, 1922; September 1, 9 and 10, 1922; April 28, 1923; and May 19, 1923. It was usually found with other small transients in willows and the smaller trees on the bar.

Empidonax minimus. (W. H. & S. F. Baird).

Least Flycatcher. (8.5.)

The least flycatcher was a fairly common transient. It was found with other small birds on the lower part of the bluff, along the creek, and on the bar. It was usually feeding or calling near the ground. Several collected. The records are between April 28 and May 20, 1923, and May 8 and 17, 1924. Fall records are between August 23 and September 4, 1922.

Otocoris alpestris praticola Henshaw.

Prairie Horned Lark. (2.)

The prairie horned lark is a resident on the cleared portions of the hills which are back away from the river. It was rarely found within the bounds of the area studied. On April 8, 1923, Mr. Frank Whittaker reported that he had found a nest with five eggs the previous week. It was on the ground in a wheat field on his farm. His description of the nest, eggs and bird agreed with that of this species. The location and the season make it almost certain that he found the nest of this species.

Two were seen along a road on June 22, 1922.

Pica pica hudsonia (Sabine).

Magpie. (.5.)

A magpie was killed on the Whittaker farm in January of 1922. The bird was mounted and is the property of a man named Byer who lives in Troy, Kan. For several days before the bird was killed it was seen with flocks of crows flying up and down creeks on the farm.

Cyanocitta cristata cristata (Linnæus).

Blue Jay. (93.5.)

Several blue jays were seen daily throughout the year, but they were much more conspicuous and more easy to locate in the winter. In the summer they were found scattered over the bluffs and along the creeks wherever there was timber, and occasionally one or two were seen in the willows on the bar. This species was often seen in the trees around houses and farm buildings. During the winter it was found along the bluff and the creek, where it fed on or near the ground most of the time. Individuals were often seen high in the air flying from one part of the area to another. The loud call of this bird was heard for long distances over the bluff and across the valley.

Although a few pairs nested on the bluff away from houses, all the nests that were found were in large trees in yards or very near farm buildings. The nests were much closer together near the buildings than they could have been in other parts of the area, according to the number of pairs that were resident in the whole area. It is evident that these birds made a definite choice for those suitable nesting sites that were near a human habitation.

On April 20, 1924, a pair was building a nest twenty feet from the ground in a maple tree in a yard near a farmhouse. One of the pair brought material and gave it to the other, and that bird placed it on the nest. On the same day another bird carried material to a nest on a horizontal limb of a large elm along a road. This nest was twenty-five feet from the ground. On May 8 two more nests were located in the yard in which the first mentioned was found. An adult was working on a nest in a large maple and twenty-five feet from the ground. An adult was brooding on the other nest, which was also twenty-five feet from the ground, and which was in an elm tree. On May 17 another adult was brooding in another elm close by along a road. This nest was thirty feet from the ground, and was on a limb which sloped upward at an angle of forty-five degrees from the horizontal. All five of these nests were within one hundred yards of one point, and all were occupied at one time.

A blue jay was carrying straw to a large elm on April 28, 1923.

A nest was seen in the yard, mentioned above, on June 3, 1923. It was twelve feet from the ground on a limb of an elm that sloped up at an angle of sixty degrees from the horizontal. The tree was within fifteen feet of a house. No birds were seen near. An adult was on the nest on June 4. On June 5 at 1 p. m. a bird brought food to the one on the nest and then left. A blue jay chased a robin out of this tree on June 15. That was the third time that that pair of blue jays had been known to clash with robins in that season. The parents were feeding young in this nest on June 22. Three young were seen in the nest on July 3. The wing feathers of one were projecting one-fourth inch beyond the sheaths. The feathers of another were still in their sheaths. Two of the young opened their mouths for food when they were disturbed. The backs of the young were covered with a dark-colored down. The nest was made of sticks and was lined with rootlets. After a few minutes one of the parents came and called excitedly. On July 8 the young birds called loudly while they were being fed. More than one was fed at each trip of a parent to the nest. On July 9 the young were seen standing in the nest and exercising their wings. On July 10 the young crawled out on a limb at least a foot away from the nest. Just after a rain on July 11 the birds crawled out of the nest and were flapping their wings. A large pilot snake was seen crawling up the tree. After an attempt to knock the snake out of the tree with rocks failed, a trip was made into the tree after it, but it had already reached the nest and had the head of one of the young birds in its mouth. The bird cried out two or three times. After it was pried out of the snake's mouth it fell to the ground dead. When the snake was dropped to the ground it at first started to crawl toward the dead young bird, but it later changed its course and crawled rapidly away. One of the remaining young birds fell out of the nest half an hour later. After it was dried it was thrown into the tree where it clung to one of the branches. Later, it crawled along the limb, but it finally fell to the ground and hopped away into the weeds near by. Neither parent was near the nest all this time. All the young were thoroughly wet after the rain. The remaining young bird was seen in the tree and near the nest on the morning of July 12. The parents were present in the morning, but the nest was empty in the afternoon, and no trace of the family was seen afterward.

On June 14, 1923, a nest was found thirty feet from the ground in a maple tree that was thirty-six steps away from the tree in which the last-described nest was located and which was in the same yard. An adult was calling excitedly, and a young bird just out of the nest was perched on a small limb of the tree and about five feet from the ground. The tail of the young bird had not yet grown out. Its color was lighter than that of the adult.

A nest was found in a box-elder tree in the above mentioned yard on June 16, 1922.

The earliest indication of flocking of birds of this species was noticed on July 13, 1923, when a group of four was flying together down the creek valley. Two of the group stopped in the tops of a large tree and began calling, while the other two kept on their way.

On July 14 a larger flock was calling loudly from the trees along the creek. Small flocks were found in the spring until about the first of April, when they began to break up into pairs for the coming nesting season.

This was one of the most quarrelsome species of bird in the area, and it was often either attacking other species or being the object of attack. The robin, wood pewee, blue-gray gnatcatcher, red-eyed vireo, and some other species showed at various times a tendency to be unfriendly with the blue jay.

Corvus brachyrhynchos brachyrhynchos Brehm.

Crow. (98.5)

The crow is one of the dominant birds of the area. Some individuals were found almost every day during the work. The number present varied from a few scattered pairs to flocks of several thousand, according to the time of year. This was one of the most conspicuous species present, and its presence could nearly always be determined with a few minutes' observation.

Crows fed on the bluff, in fields, on the bar, on newly-formed sand bars in the river, and at the lake. Especially in the winter large flocks were to be found at all times of the day in some part of the lake or perched in the near-by trees on the bar. The birds walked on the mud at the edge of the water, and when the water was low or was frozen they scattered over the lake and picked up various kinds of plant and animal food.

On March 30, 1923, one was seen flying over the lake. It paused in the center and stopped in the shallow water. It then moved a short distance and picked up an object from the water which it carried to the shore and began eating. The bird was driven from its meal, which upon investigation proved to be a gar pike (*Lepidosteus platystomus*) about eight inches long. Another crow picked up some small object in the water, which it carried to the shore and began eating in the same way. Two other attempts to catch fish, that were made by crows flying across the lake, were failures.

The large crop of *Nelumbo* seeds that was produced each year furnished an easily obtainable food supply for the flocks of wintering crows. The stalks which bore the ripened seeds did not usually fall below the surface of the shallow water in which the plant grew, and it was easy for a crow to pull off one of the heads full of seeds and carry it to some place on the shore to pick them out to be eaten. Sometimes the seeds were not carried away to be eaten, but they were pulled out of the heads, cracked and eaten where they were found. Empty shells of the seeds of this plant and empty heads were found scattered over the bar and the bluff near the lake. From the first of December until the first of April this plant furnished one of the important sources of food for the wintering crows. Of course, several other kinds of food were available at the lake and near by on the bluff and on the bar, but they were usually present in lesser abundance.

On January 27, 1923, a large flock of crows was feeding in a burned-over field. Another flock was feeding on the ground in the willows near the lake, where the leaves and weeds had been burned. On January 28, 1923, a crow was feeding on a rabbit that had been used to bait a trap.

About two hundred crows were feeding all day of March 30, 1923, on a ten-acre cleared field on the bar that was being plowed. The field was being plowed in one "land" from the outside to the center. The feeding crows were watched when three-fourths of the field had been plowed. They were scattered entirely around the field and were chiefly on the inside furrow, or the one that had been plowed last. Those birds in front of the plow moved ahead and those behind kept close, so that practically all the exposed dirt was searched over by the feeding birds. In one trip of rapid walking around one of the open furrows thirteen white grubs, three beetles (*Lachnosterna*), one pupa of a beetle, and another kind of insect larva, were picked up, and a like number of earthworms was seen. This was probably very much less than the amount eaten by the crows in each furrow. The total amount of animal life eaten in this field in a day must have been large. The birds were continually arriving and leaving, but the number feeding did not change greatly. The near-freezing temperature might have killed the grubs if the crows had not been present. These birds were much more tame in this field than in other parts of the bar.

A stomach of a crow that was shot on January 26, 1923, contained one part insects (Hemiptera) and thirty-three parts corn. The stomach of one shot on January 27, 1923, contained eight parts corn, one part insects, and a few spiders. One that was collected on January 28, 1923, had in its stomach the equivalent of six grains of corn and one grain of wheat. At the time when these birds were collected, practically all of the corn from the vicinity in which they were feeding had been gathered, and they could have obtained scarcely any except that which had been left in the field and which was waste. The contents of four other stomachs that were taken from birds that were killed in the winter were much the same as these except that two of them contained the remains of seeds of *Nelumbo lutea.*

Not a single instance of damage by the feeding of crows was noted in this area during the time of observation, and the facts obtained show that within this area and at the time of these observations the crow was almost entirely beneficial.

A large flock was feeding on the carcass of a dead pig that was on the bar on February 6, 1924.

On winter days crows were often found perched in trees on the bar or on the bluff, where they were usually in small flocks that were calling. Although there were no winter roosts within this area, crows were seen flying up the creek valley nearly every morning in winter, and some were seen flying down the valley toward the east nearly every evening. Usually they flew over the river and a little north of east.

On March 2, 1924, one was chasing another into the air and one was calling. The flocks were not so condensed, and the birds called more than they had at other times during the winter.

At one place on the bar, on March 31, 1923, a crow gave a call note of alarm. Immediately several hundred others assembled from every side, but after flying overhead and calling for a few minutes they left. Fifty yards away a nest was found that appeared to be one of the season and unfinished. Another nest was found on the bar on the south side of the creek. Near it an adult called and left. On April 1, 1923, a nest was found thirty-five yards away from the last-mentioned nest, and another was found fifty yards from the latter. Another bunch of new nest material was found in a near-by tree. All the nests were in cottonwood trees, and they were unoccupied. All the crows that were noted seemed to be restless and to be preparing to nest. Often pairs would leave a flock to fly after one another. On April 7 another nest was found in the group on the bar south of the creek. It was twelve feet from the ground in a cottonwood tree and contained one egg. One of the nests in this group was empty, one held three eggs, and another held five eggs. The crows flew from the nests without making much noise. One bird was sitting on one of the nests on April 28.

On April 20, 1924, a brooding adult left a nest that was twenty-five feet from the ground in a medium-sized elm along the creek. The bird did not fly until the tree was struck.

A family of young crows, just able to fly, was found with a pair of noisy adults in the timber near the bluff on May 29, 1924. A family of young birds was leaving a nest, on the bar, that was fifteen feet from the ground on June 8, 1922.

A nest was found twenty feet from the ground in an oak tree in a ravine on the Whittaker farm on June 11, 1922. The nest was one hundred yards from a Cooper's hawk nest. There were three or four young birds, without feathers, in the nest. No adults were seen near by in the morning or in the evening.

Large flocks of crows were usually found on the area from early fall until early spring. When moving from one place to another the flocks did not usually move together, but moved in smaller groups that followed one another.

On February 17, 1923, a mounted great horned owl was placed in a tree near an old house on the bluff north of the lake. At 3:30, or one hour after the skin was placed in the tree, the crows discovered it and began calling. Within five minutes twenty-five or thirty were calling in the near-by trees. At 3:36 one of the birds was shot. Most of the others left. After one minute they began to return. Then they left, except three which stayed for five minutes. They may have noticed a movement in the building or they may have discovered the fraud. Whenever an owl or a hawk was flushed it was usually discovered and surrounded by a flock of crows within a few minutes.

A much larger number of crows was present during the winter and the seasons of migration than during the summer, when they were usually scattered.

Molothrus ater ater (Boddært).

Cowbird. (45.)

The cowbird was found almost daily during the summer. It was usually found singly or in small groups of three or four. It was found in willows on the bar, along the creek, and in trees on the bluff, as well as on the ground in the fields and pastures, where it was often associated with feeding herds of stock.

Females of this species were often seen in the summer, crawling among the branches of trees on the bluff and on the bar, searching every limb, presumably for nests of other birds, in which the cowbirds might lay their eggs. Species in whose nests cowbird's eggs were found or that were seen feeding young cowbirds are: *Empidonax virescens, Spiza americana, Cyanea passerina, Vireosylva* *olivacea, Icteria virens virens, Geothlypis trichas trichas, Thryothorus ludovicianus ludovicianus, Hylocichla mustelina,* and *Cardinalis cardinalis cardinalis.*

The latest record of a young bird is August 31, 1923, when one was being fed by a cardinal. Young were being fed by a Carolina wren on June 17, 1923.

During the seasons of migration this species was found mixed in the flocks of other kinds of Icteridæ that flew over and fed in the fields during the day. The earliest record is April 1, 1923, and the last fall record is November 4, 1923, when some were seen in flocks of grackles.

Xanthocephalus xanthocephalus (Bonaparte).

Yellow-headed Blackbird. (1.)

On May 4, 1924, a yellow-headed blackbird was seen along a slough near the lake on the bar, and one was in a small tree near Doniphan lake. There were several in the *Typha* in the lake on May 17.

One nest of this species was found in *Typha* in the lake on May 30, 1924. It was in a clump of stems, and was two feet above the water. There was no bird on the nest, which contained the shells of some broken eggs of this blackbird.

Agelaius phœniceus phœniceus (Linnæus).

Red-winged Blackbird (63)

Not enough specimens of this species have been collected at this location to determine the seasonal occurrence of each of the four subspecies that are found here at some time in the year.

In summer this bird was common in suitable parts of the area, and in the migration seasons it was very common in flocks. Part of the time in the winter one or more subspecies were common.

In summer this bird was found in colonies around the lake, in the willows near the mouth of the creek, and at the marshy places below springs on the bar. At other times it was more general in its distribution, being found in trees along the bluff, on the bar, or in yards, and sometimes on telephone wires along roads. Once a flock was resting on piles of drift that were on the bar. On March 30, 1923, one was feeding on the ground in a burned-over clover field. On February 3, 1924, about four hundred came to a weed patch near the creek on the bar. They came in flocks of about fifty, and the flocks arrived from a few seconds to several minutes apart. All settled together. After a few minutes they flew to the tops of cottonwood trees near by, and then left in small flocks which flew toward the east. Nearly all were females. On March 29, 1924, some large flocks were seen feeding on the ground and in cornfields on the bar.

In the evening of March 1, 1924, some birds of this species were going to roost in the *Typha* in the lake. Small flocks kept moving from one part of the lake to another until it was too dark for them to be seen across the lake. Some stopped in the *Typha* in the evening of September 22, 1923. A few were seen to stop in patches of *Nelumbo* in the lake.

This blackbird was rather closely restricted to the immediate vicinity of its nesting ground in the summer. Few were seen away from there.

On May 29, 1924, three nests with four eggs each, one nest with three eggs, and several unfinished nests, were found in the *Typha* growing out of the water south of the lake. The nests were from two to three feet from the ground. Near all of them adults were calling, but only one female was seen on a nest. On May 30 three nests with four eggs each, one nest with three eggs, and one nest with one egg, were found in the *Typha* that was growing in the water of the lake. Some females were seen gathering nesting material, and several nests were found that were just started, as well as several that were nearly finished. Those nests that were nearly finished were wet. Several of the nests were within sight of others and two were within twelve feet of one another. The nests were from six inches to two and one-half feet above the water. Adults came near and called when the nests were approched, but they were not very noisy.

A nest was found on June 5, 1923, which was five and one-half feet from the ground, in a willow ten feet high that was growing one hundred yards from the bluff on the bar. A female was sitting on four eggs. Another nest with four eggs was found in a willow near the mouth of the creek. It was six feet from the ground.

A nest was found two feet from the ground in *Typha* in a marshy place on the bar on June 9, 1922. A female was brooding.

On June 12, 1922, a nest was found with five young that was four feet from the water in a willow at the edge of the lake. A nest containing three eggs was found in *Typha* at the lake on June 14, 1922.

On June 27, 1923, a female was seen at the edge of the lake carrying a straw, and another was seen carrying an excreta sac which it dropped while flying.

The earliest date on which flocks of this bird were seen in the summer is July 17, 1923. In the early spring it was found in flocks as late as April 22, 1924. During the seasons of migration it often joined with other members of its family, especially with the bronzed grackle, in large flocks, which fed over the country together in the daytime and went to roost together in the evening. In the fall these flocks were often seen flying east down the creek valley just before dark. Several small flocks sought protection from cold in thickets of willows on the bar on March 4, 1923.

After the nesting season these birds were moulting, and they were not often seen, except singly, until about the middle of September. On September 5, 1923, most of those that were seen flying across the lake were tailless.

Sturnella magna magna (Linnæus).

Meadow Lark. (4 5)

Since within this area there was an almost total lack of conditions that resembled prairie, there were few meadow larks. Most of those that were seen were in the upland fields and pastures. Some were seen along the roads within the area.

On October 7, 1922, one was flushed on the flat and nearly bare ground on the south side of the lake. Another was found in almost the same location on November 18, 1923. Although the bird was silent, and thus could not be identified by its notes, it is believed, on account of its light color, to have been *Sturnella neglecta*.

A meadow lark was carrying nesting material in a small bluegrass pasture near the north edge of the area on June 20, 1922.

Icterus spurius (Linnæus).

Orchard Oriole. (30 5)

A few individuals of this bird were seen almost daily during the entire summer season. It was found in the trees along the bluff, along the creek, on the bar, and in yards around the houses. During the early fall migrations it was found feeding with small transients in the weed patches along the creek. Two young males perched in the tops of clumps of *Typha* in the south part of the lake on June 27, 1923. They sang, and after a few seconds, flew on toward the river. Birds of this species often chose a perch near the top of a tree from which to sing.

A pair was seen feeding a young bird just out of the nest in the E. V. Roundy yard on June 19, 1922. On July 3, 1923, one carried a straw to a nest in the top of a cottonwood near the creek at the edge of the bar. A pair was seen mating in the top of a medium-sized tree in the E. V. Roundy yard on June 4. A nest was found thirteen feet from the ground in the top of a willow on the south side of Doniphan lake on June 7, 1923. A female flew off the nest. After five minutes the male came and perched in a near-by tree. On June 26, 1923, a female brought straw and wove it into the beginning of a nest at the end of a hackberry in the E. V. Roundy yard. This nest was fifteen feet from the ground.

Young birds were seen leaving a nest on July 16, 1923.

A small flock was feeding in weeds along the creek on September 13, 1923.

The first arrival in the spring was noted on May 6, 1923. In the fall none was seen after September 15, 1923.

Icterus galbula (Linnæus).

Baltimore Oriole. (52.)

The Baltimore oriole was found daily in the summer, and usually several were seen each day. It was most common in the large trees around the farm buildings, but it was also found along the bluff and in the trees on the bar. In the fall it sometimes fed in weed patches along the creek.

A female was working on a nest ten feet from the ground in the end of a drooping branch of a maple in a yard on June 4, 1923. A male was singing near by. An incomplete nest was found in the top of a willow tree on the bar on June 6, 1922. A pair of orioles chased a blue jay away from the vicinity, after which the male sang from a near-by tree.

A male was feeding young in a nest at the end of a drooping limb of a large elm in a yard on June 14, 1922. On June 17, 1922, a nest with young was found thirty-five feet from the ground in the top of an oak tree in the timber on the side of a hill north of the lake. Both adults brought food to the young, which called loudly. A nest with young birds was found in a yard on June 26, 1922. It was twelve feet from the ground. Young birds were found in nests as late as July 18, 1923.

Several birds of this species, that were seen together in an oak tree on the bluff on June 29, 1923, may have been the young of a single family. Small flocks were seen in the tops of trees along the bluff, and with other transients, on May 10, 1923, and May 12, 1923. They stayed in compact flocks. In the fall this species was often a conspicuous part of the feeding and migrating flocks of small birds. On August 27, 1923, this bird was the most common transient in the flock which was feeding in the tops of the trees along the lower part of the bluff. These birds were calling and keeping close together as they fed.

May 6, 1923, is the earliest record for the spring. The latest fall record is September 6, 1923. In 1922 it was last seen on September 2.

Euphagus carolinus (Müller).

Rusty Blackbird. (25)

One of two rusty blackbirds in a small tree along the lower part of the bluff was shot on April 7, 1923. On November 4, 1923, flocks were seen with other blackbirds in the tops of cottonwood trees along the lower part of the bluff north of the lake. The species was seen on November 17 and 18, 1923. On December 1, 1922, one flew from the top of the E. V. Roundy barn to a corn crib.

Quiscalus quiscula æneus Ridgway.

Bronzed Grackle. (195)

In summer the bronzed grackle was infrequently seen within the area studied. It was abundant during the seasons of migration, and sometimes flocks of several thousand were seen. A few were occasionally seen in winter.

Most of the birds of this species that were seen were flying over the area. Sometimes they stopped in the tops of the trees in yards or along the bluff. In the evening of November 3, 1923, several large flocks were flying south along the bluff to a place where they were gathering for the night. Just before dark, on October 20, 1923, small flocks of from one hundred to two hundred birds formed an almost continuous line, flying over the lake from the southeast to the willows on the north edge of the lake. They kept moving back and forth, in flocks, from the edge of the water to the trees. The noise that the flock made could be heard plainly on the bluff west of the lake. Large pine trees near houses were favorite resting places for this bird.

Three were feeding among leaves on the ground on the bluff near the lake on January 24, 1923. One of these appeared to have a broken wing.

One that was seen in the yard at 6:30 in the morning of June 13, 1923, was eating corn at a sheller.

The nest of this species, that was found nearest to the area, was twenty feet from the ground in the top of a box elder along the creek, near Doniphan. An adult was seen flying to the nest on June 17, 1923. Another adult was carrying food near the same creek.

Several good-sized flocks were seen flying down the river on October 28, 1922. They appeared to be following the west bank. Just before dark on that day a flock, stretching in a thin line from the west bluff out over the river as far as it could be seen with a four-power glass, flew down the river. It was flying at a considerable height. On November 8 and 9, 1924, several flocks were seen flying up the creek valley in the morning and down the valley and east over the river in the late afternoon and evening.

The greatest number of this species was present in the spring during the last of March and the first of April, and in the fall from early September until late in November, but small numbers were present throughout the year.

Carpodacus purpureus purpureus (Gmelin).

Purple Finch. (9.5.)

Purple finches were present in groups of two or three flocks of twenty or thirty. They fed in winter in the weed patches along the creek, on the bar, and in the trees and near the ground on the lower part of the bluff. Flocks were often found resting and singing in the willows on the bar and in the small trees on the lower part of the bluff.

This bird was found from October 20, 1923, the earliest fall record, until May 6, 1923, the latest record for the spring. There are no records for December.

Astragalinus tristis tristis (Linnæus).

Goldfinch. (82.)

Goldfinches were seen almost daily. In the summer this bird was found in pairs and at other times of the year it was in small flocks. It fed at the edge of the timber, along the roads, in weeds and willows on the bar, in timber along the creek and on the bluff, in patches of *Typha* at the lake, in fields and in yards. Weed patches were the favorite feeding grounds in winter.

Individuals were several times found bathing in pools in the creek.

No nests were located, although pairs of this species were seen together throughout the summer.

In the fall migration these birds joined the flocks of feeding birds that were present on the bar and along the creek. In the spring they were found with transients singing and feeding in the tops of the trees as they were coming into leaf.

Spinus pinus (Wilson).

Pine Siskin. (8.5.)

The pine siskin was present during the winter in flocks, which were usually not large. It fed with other sparrows in the weeds and trees on the bar, along the lower part of the bluff, and along the creek. Many times it was found with purple finches or other species of the small winter residents.

Records of the occurrence are in the winter months between November 3 and March 16.

Passer domesticus (Linnæus).

English Sparrow. (99.5.)

This sparrow was conspicuous, and was seen daily because it was always present in the vicinity of farm buildings. In other parts of the habitat it was not present, throughout the year. It was most numerous in yards and around buildings in the summer. In the winter it joined the flocks of native sparrows to feed in patches of weeds along the creek. Compact flocks were often found in brush piles on the bar in the winter. Many were feeding in a millet patch on August 23, 1923.

The English sparrow nested in holes and nooks about buildings and bridges and in holes in trees in yards. Birds were seen carrying nesting material as late as July 19, 1923. On July 4, 1923, a nest containing one egg was found that was built on the nest of a robin that was in an apple tree in an orchard.

Passerculus sandwichensis savanna (Wilson).

Savannah Sparrow. (1.5.)

This bird was found only three times. One was shot in the top of a small tree on the lower part of the bluff on April 8, 1923. Other records are for birds in the willows on the bar on April 21 and 22, 1924.

Ammodramus savannarum australis Maynard.

Grasshopper Sparrow. (2.)

This sparrow was found in summer in fields on the Whittaker farm. One was shot in an alfalfa field on September 5, 1922.

Passerherbulus lecontei (Audubon).

Leconte's Sparrow. (1.5.)

Single birds of this species were seen in the weeds at the side of a road on April 1 and 7, 1923. One was shot in grass in a marshy place on the bar north of the lake on April 17, 1923.

Chondestes grammacus grammacus (Say).

Lark Sparrow. (4.5.)

A few single lark sparrows were found in pastures and fields and along roads. On June 9, 1922, an adult was brooding four young in a nest on the ground. This nest was in a weed patch at the top of a vertical bank on the Whittaker farm.

One was seen in the brush along the creek on May 8, 1924. Another was seen in a sandy field at the edge of Doniphan lake on May 13, 1923. The only fall record is for September 3, 1922.

Zonotrichia querula (Nuttall).

Harris' Sparrow. (14.5.)

The Harris' sparrow was found during the winter in small scattered flocks in brushy and weedy places on the bar, on the bluff, and along the creek. Piles of brush on the recently cleared ground on the bar and on the bluff were favorite places of refuge for small groups of these birds. On March 30, 1923, one was feeding on the ground in a burned-over clover field.

In the spring this sparrow was present between January 25 and May 13, 1923, and between February 7 and May 8, 1924. Fall dates are between October 20 and December 2, 1923, and October 28 and 29, 1922.

Zonotrichia leucophrys gambeli (Nuttall.)

Gambel's Sparrow. (.5.)

One was shot at the top of the creek bank on the bar on May 4, 1924. Another was seen in a brush pile on the bar on March 21, 1925.

Zonotrichia albicollis (Gmelin).

White-throated Sparrow. (8.5.)

The white-throated sparrow was usually found in small groups of from two to six individuals. It fed in weed patches along the lower part of the bluff, along the creek, and in the brushy places on the bar. It was sometimes found with Harris' sparrow.

The records of occurrence in the spring are between April 8 and

May 13, 1923, and April 5 and May 3, 1924. In the fall this bird was found between October 6 and November 3, 1923.

Spizella monticola monticola (Gmelin).

Tree Sparrow. (22.)

The tree sparrow was one of the most common winter residents of the area. It was found in considerable numbers daily throughout the winter, and it was usually present in loose flocks that were feeding. It fed among weeds on the bar and on the bluff, and in *Typha* near the lake.

October 21, 1923, and April 14, 1923, are the earliest and latest dates of winter occurrence of the tree sparrow in this area.

Spizella passerina passerina (Bechstein).

Chipping Sparrow. (2.)

Although one or two pairs of chipping sparrows probably nested within the limits of the area studied, no nests were found, and inviduals were seen only four times. On April 22, 1924, a pair was seen in trees in a yard. One was shot in an alfalfa field on May 12, 1923. One was singing in the top of a tree in a yard on June 11, 1922. Another was singing in the top of a tree in a yard on June 28, 1922.

Spizella pallida (Swainson).

Clay-colored Sparrow. (.5.)

One was shot that was singing in brush and shrubbery along a road on April 20, 1924.

Spizella pusilla pusilla (Wilson).

Field Sparrow. (34.)

Several pairs of field sparrows nested in suitable parts of this area. This bird was found in brushy fields, in openings in the timber on the bluff and on the bar, in brush at the edge of timber, and in clearings along the creek. It was more often heard singing than it was seen. It was heard singing as late as September 6, 1923.

On June 14, 1923, a nest was found one and one-half feet from the ground in a clump of coral berry in the edge of a pasture on top of the bluff. It contained one egg. Another was found three feet from the ground on a horizontal limb of an oak sprout eight feet high on July 18, 1923. The nest was shaded and contained two eggs.

April 7, 1923, and March 19, 1925, are the two earliest records of spring arrival. October 11, 1924, is the latest fall record.

Junco hyemalis hyemalis (Linnæus).

Slate-colored Junco. (30.)

Throughout the winter this bird fed in large groups in weeds and brush on the bar, on the bluff, and along the creek. Although it was nearly always on or near the ground, it was sometimes found in the tops of trees. It was sometimes found in brush piles.

In the winter juncos were often flushed in the evening after they had gone to roost in small holes in banks along the roads or on the bluff. They seemed to prefer places that were protected from the wind and where there was a ground cover of loose leaves. Sometimes they were found at night in the tops of shocks of corn in the fields. On January 12, 1923, some were seen going to roost as early as 4:30 in the afternoon.

This species contributed the largest number of individuals to the large flocks of seed-eating winter resident birds.

Juncos, before they left in the spring, were often heard singing from perches in trees.

The earliest date of arrival in the fall is September 24, 1922. In the spring the bird was found as late as April 22, 1924.

Melospiza melodia melodia (Wilson).

Song Sparrow. (26.5)

Several individuals of this species were seen on each day of work in the winter. They were found scattered singly or in small groups that fed near the ground on the bar and on the bluff. They preferred the vicinity of the lake, and were often flushed from thickets of *Typha* or from weed patches near the water. These growths may have been used for their protective value as hiding places more than for feeding. Birds that were flushed while feeding near by nearly always flew hurriedly to these thickets.

Singing birds were heard in both the fall and the spring.

October 7, 1922, is the earliest fall record, and May 12, 1923, is the latest record for the presence of this bird in the spring. Most of the song sparrows left before the middle of April in both years.

Melospiza lincolnii lincolnii (Audubon).

Lincoln's Sparrow. (13.)

The Lincoln's sparrow was found singly, or in small groups of two or three individuals, near the ground in brushy growths on the bar and in the timber on the bluff. It was also found in the fields and along roads. Some were seen in the wet, grassy places on the bar

A female was brooding on a nest in roots under an overhanging bank along the creek on April 20, 1924. The nest was seven feet above the level of the creek bed. It contained three eggs.

On April 28, 1923, a female flew from an empty and unfinished nest in roots four feet below the top of another overhanging bank along the creek. A nest with one egg was found in a vertically hanging grapevine over the creek on May 8, 1924. The nest was seven feet above the water in the creek.

A nest was found four feet from the ground in some brush on the lower part of the bluff on May 11, 1924. It contained two eggs of the cardinal and one of the cowbird. On the ground near by there was another egg of the cardinal, which was broken. A female was near by.

On May 12, 1923, a nest was found in a leafless sapling on a slope of a ravine on the bluff. In it there were two eggs which had holes in their sides one-fourth inch by three-eighths inch in diameter. Each was about half empty. Otherwise the nest appeared to be undisturbed. It was six feet from the ground. This is an example of the dangers which come to nests that are placed in too conspicuous places. On the same day a female was found sitting on a nest five and one-half feet from the ground in a grapevine under a leaning tree on the lower part of the bluff. Another female was brooding three eggs in a nest three feet from the ground in a small scrubby tree on the lower part of the bluff.

On May 26, 1923, a female was sitting on four eggs in a nest in a rosebush along the bluff near the lake. The nest was five feet from the ground. The brooding female did not fly until she was approached closely enough to be touched. She then called very nervously.

A nest was found three feet from the ground in a willow near Doniphan lake on June 3, 1923. There was one egg in the nest, but no bird was in sight.

On June 7, 1923, a brooding female flew from a nest six feet from the ground in the top of a fallen cottonwood, which had its leaves at this time. The tree was on the bar northeast of the lake.

On June 8, 1922, a nest was found four feet from the ground in a clump of elder near a creek. Of the three eggs that had been in the nest only one was left. The others probably had been thrown out by cattle walking through the brush. Another bird was carrying straw and starting a nest three feet from the ground in an elm sprout at the side of a road. On June 13 there was one egg in the nest. A female was brooding young in this nest on June 28.

A nest was found on June 9, 1922, which was six feet from the ground, in a box elder on the side of a pasture ravine on the Whittaker farm. It contained four eggs, one of which was a cowbird's egg. On the same farm a female was sitting on another nest in an Osage orange tree. This nest was six feet from the ground and had three eggs in it.

A female was sitting on an empty nest six feet from the ground in a shrub covered with a grapevine that was growing on the side of the bluff on June 10, 1922. On June 16 there were two eggs in the nest. On June 10, 1923, a female was brooding two young with wing quills that were in a nest four feet from the ground in coral berry along the lower edge of the bluff. The female flew off when the bush was touched and called nervously from a near-by perch. On June 13 the wing feathers of these birds were beginning to break through the sheaths.

A female was brooding on a nest seven feet from the ground in a grapevine that was growing on a horizontal limb of a small sycamore that was growing at the lower edge of the bluff. The bird left the nest when the vine was touched.

On June 14, 1923, a nest was found three feet from the ground in a leaning dogwood on top of the bluff. The nest was made of leaves, grasses, stems and grapevine strippings. There were three young, with wing feathers showing one-fourth inch beyond their sheaths. They called when they were disturbed, but later became quiet. One of them opened its red-lined mouth. An adult male, with a caterpillar in its mouth, called anxiously near by. A pair of chats came and called.

A female was sitting on a nest nine feet from the ground in ivy that was growing on the trunk of a cottonwood at the edge of a clearing on the bar near the lake on June 19, 1922.

On June 24, 1922, a female was building a nest ten feet from the ground in a willow which was one hundred yards from the edge of the bluff and on the bar.

A pilot snake was taken out of a nest in a grapevine which was growing on a large willow along the creek on July 4, 1923. The nest was ten feet from the ground. Both parents called excitedly from near by.

On July 6, 1923, a female was flushed from a nest eleven feet from the ground in a grapevine that was growing over a mulberry on the lower part of the bluff near the lake. The nest was near the top of the tree. A male called near by. Another female was working on a nest twelve feet from the ground on a leaning horizontal limb of a small tree in the bottom of a ravine north of the lake on July 10, 1923, one of the hottest days of the summer. A male that was in the same tree left with the female. Work on the nest had just started.

A pair was building a nest in a drooping limb of an elm tree along the creek on July 13, 1923. The nest was nine feet from the ground and was shaded by the rest of the tree. The female gathered the material from the ground and from among the roots of fallen trees on the opposite side of the creek, and from one hundred to two hundred yards away, and carried it directly to the nest. On each trip the male followed fifteen or twenty feet behind the female and stopped ten or twenty feet beyond where the female stopped. The birds were watched between 10:30 and 11:30 in the morning.

A pair called nervously near a nest five feet from the ground in a leafless willow on the bar on July 17, 1923. The nest was made of fine twigs and was fastened to the main trunk by small branches. It contained one egg.

A nest with three eggs was found six feet from the ground in a hickory sprout ten feet high at the edge of the timber on top of the bluff on July 19, 1923. The nest was on a horizontal limb and was unshaded. A female was brooding three eggs.

August 25, 1923, is the latest date on which a nest was found with eggs. The nest found then was five and one-half feet from the ground in an oak sprout at the side of the road, and it contained two eggs. It was unshaded. The brooding female left when approached to within ten feet and called nervously.

A pair was feeding a young cowbird on the bluff on August 31, 1923. A young cardinal, just out of a nest, was seen on September 13, 1923.

Cardinals were frequently found in flocks during the winter. These flocks were made up of birds of both sexes and were rather compact. They moved through the tops of the trees or fed with other sparrows along the creek, on the bluff, or on the bar. In March these flocks broke up into pairs that began to prepare for the coming nesting season.

Hedymeles ludovicianus (Linnæus).

Rose-breasted Grosbeak. (33.)

The rose-breasted grosbeak was represented during the nesting season by only a few pairs of adults. It was found in orchards, in trees around farm buildings, along the bluff, and in trees along the creek. In the season it became more numerous, and was found with other transients on the bar and in other parts of the area. These birds usually fed in the tops of the trees, and when singing the males chose perches in the tops of living or dead trees.

A nest was located seventeen feet from the ground in the top of an apple tree in an orchard on June 13, 1923. It was in a fork of an upright limb, and was made almost entirely of the tendrils of grape. Three young birds, several days old and covered with light gray down, were in the nest. A male called very nervously and flew about the tree when the nest was disturbed. No female was seen. A pair of robins seemed to be concerned about the welfare of the nest, for they came to the vicinity of the nest and called when it was disturbed.

A dead female was hanging from the edge of a nest ten feet from the ground in a box elder along a creek at Doniphan on June 17, 1923.

First records for this species in the spring are May 5, 1923, and May 4, 1924. In the fall it was seen as late as September 10, 1922, and September 15, 1923. Small groups of feeding transients were seen together in the fall as early as August 24, 1923, when they were in trees along the creek. Usually this species did not form compact flocks, but was scattered among the larger flocks of other small transients.

Passerina cyanea (Linnæus).

Indigo Bunting. (65.5.)

The indigo bunting was one of the most numerous summer resident birds of the area. It was uniformly distributed over the terrestrial part of the area, and especially chose those places where the covering of vegetation was composed of brushy shrubs. It preferred the edges of clearings, roadsides, the weedy boundaries of fields, and overgrown fields of weeds and sprouts. Although usually near the ground, it was sometimes found in the tops of trees.

A female was seen carrying straw in an opening in the timber near the top of the bluff on June 4, 1923. Mating pairs were seen on June 8 and 12, 1923.

A female was brooding three eggs and one egg of the cowbird in a nest which was two feet from the ground in a coral berry along a fence on June 13, 1923. There was a thick growth of nettles four feet high surrounding the nest.

A nest with four young about half grown was found in a small bush along a road on the bluff on June 16, 1922. On the same day another nest was found in a coral berry along the same road. It was one foot from the ground, and held two young about the same age as those in the other nest. The parents were very shy, and did not come near the nest for over half an hour after it was found except once, when the female flew over it. A loosely built nest, that was nearly hidden by leaves, was found five and one-half feet from the ground in the top of a dogwood on the bar north of the lake on June 16, 1923. A female that was sitting on three eggs and one cowbird's egg did not leave until she was almost touched. Both birds called excitedly.

On June 19, 1922, a female was brooding three eggs and one cowbird's egg in a nest nine feet from the ground in a crotch of the main trunk of a young cottonwood. The nest was on the bar, and twenty-five yards from the lower edge of the bluff.

A female was calling near a nest one and one-half feet from the ground in a small elder in a sprout field on top of the bluff on June 26, 1923. In the nest were four young and one egg of the cowbird. The nest was shaded.

A nest was found six feet from the ground in a grapevine on the bluff on June 28, 1923. A female that was brooding three eggs flew off and called when approached.

On June 7, 1923, a nest was found three feet from the ground in the edge of the willows on the bar. It was in a small sycamore sprout, and contained two young and one young cowbird. The cowbird was about twice as large as the young buntings, and was very much more active. The nest was twisted out of shape by the activity of the young cowbird.

Four nests were found in weeds on the bar on July 17, 1923. One was three feet from the ground at the side of a cow path through wild hemp about five feet high, and growing in a dense thicket. There were two eggs in this nest. Another was four feet from the ground and was fastened between two stalks of hemp. It contained two eggs that were nearly white, each of which had a few spots of brown pigment near the larger end. The spots were small. The brooding female left when approached to within ten feet. The third nest was twenty-five yards from the second, and was four feet from the ground. It was fastened between three stalks of hemp. The female was brooding three light eggs. She left when approached to within five feet. The fourth nest was three feet from the ground in a thistle. It hung between two leaves of the plant. There were three small young in this nest. The female came with food after several minutes. Both parents called in the vicinity.

A female was seen carrying a caterpillar in the edge of the timber on top of the bluff on July 19, 1923.

A nest was found August 18, 1923, that was five feet from the ground in a clump of weeds near the creek on the bar. The brooding female would not leave the four eggs in the nest until she was almost touched. Then she flew near the ground and fluttered as if with broken wings. There were young birds in this nest on August 30.

A nest was found four feet from the ground in sumac along a road on August 23, 1922. It contained four young, whose wing feathers had sheaths that were nearly ready to break. On August 23, 1923, a female with some young, just able to fly, was found in the center of a cornfield on the bar. The parent called nervously. The young birds perched on the stalks of corn and about half way to the top.

Records of arrival in spring are May 6, 1923, and May 8, 1924. The latest fall records are October 8, 1922, and October 7, 1923.

Spiza americana (Gmelin).

Dickcissel. (36.5.)

Several pairs of this species nested in suitable parts of the area. The bird was usually found in summer in weedy fields and openings on the bar and on the bluff. It was also found in brushy places in pastures, along roads, and in the border of brush at the edge of timber, especially on the top of the bluff.

This bird was often heard singing at night as well as in the daytime. It usually sang from a low perch.

A nest was located two feet from the ground in an elder in a pasture on the Whittaker farm on June 9, 1922. It contained three young and one egg.

On June 12, 1923, a nest was found one foot from the ground in a blackberry bush that was three feet high, and growing in the strip of weeds and shrubs between a wheat field and the timber on top of the bluff. The nest was little shaded, and contained five eggs and one cowbird's egg. The female on the nest flew off when disturbed and called with the male for a few seconds. Then both left.

A female was brooding four eggs in a nest four feet from the ground and in an elder in a brushy field on top of the bluff on June 13, 1923. The sitting bird called once or twice and left. The nest was partially shaded by a bush at the edge of the clump.

On June 22, 1923, a male with a young bird just able to fly was seen in a thick growth of sweet clover in a hog pasture on top of the bluff. An adult with young was found in the tops of trees on the lower part of the bluff on July 9, 1923.

On July 14, 1923, a nest was found, three and one-half feet from the ground, in the crotch of an elder which was growing at the side of a road. The bush, which was about five feet high, shaded the nest. There were four young with down, The parents were perched on a telephone wire overhead. The female brought food and approached the nest after about five minutes. The male was singing. It left its perch to fight with another male about twenty yards away.

A pair was found on July 19, 1923, with young just able to fly They were in the weeds along the creek. A young bird flew from a nest three feet from the ground in a thistle near the creek on the bar on August 23, 1923. A young bird was killed in the weeds along a slough on the bar on August 31, 1922.

April 28, 1923, is the earliest record for the arrival in the spring September 7, 1922, and September 13, 1923, are late dates in the fall

Piranga erythromelas (Vieillot).

Scarlet Tanager. (6.5)

A few pairs of this tanager were summer residents within the limits of this area. All of them were found on the bluff, and they spent nearly all their time in the tops of the trees there.

Four different males were heard singing in one section of the bluff one-quarter of a mile long on May 6, 1924. On May 12, 1923, a pair was seen on the bluff. A second male approached and was chased away by the first, which then returned to the female. On July 14, 1923, a male was singing in a tree over the road near the creek. Its song was so low that it could scarcely be heard on the ground directly under the tree.

On June 15, 1922, a nest was found twenty feet from the ground in a shellbark hickory on the lower part of the bluff. The nest was small, and was placed on a horizontal limb one and one-half inches in diameter. The female was sitting very closely and did not leave the nest when sticks were thrown into the tree or when other noises were made below the tree. Finally, she was driven off by kicking the base of the tree. She flew a short distance to another tree and called nervously.

May 6, 1923, is the earliest spring record for this bird.

Piranga rubra rubra (Linnæus).

Summer Tanager. (9.5.)

The summer tanager was represented, in summer, in this area by only a small number of nesting pairs. This bird was inconspicuous and was not frequently seen. It was found in trees in farm yards, along the creek, and on the bluff.

On June 16, 1922, a pair was seen four or five times flying about in a yard, and especially in a box elder in which there was a nest of a pair of blue jays. On June 18 the female was seen carrying material to this tree, where she was building a nest on a horizontal limb ten feet from the ground. She kept calling all day. The male was not seen. The female was working on the nest on June 19. On June 21 and 22 she was heard calling in the yard, but was not seen near the nest. The female was sitting on the nest most of the day on June 23, when both adults were near the nest. Once the male was seen giving the female food about ten feet away from the nest. On June 26 there were three eggs in the nest.

A nest was found on a horizontal limb in the top of an oak tree on the bluff west of the lake on June 21, 1923. When the tree was hit the female flew off the nest and to a near-by tree, where she called for several minutes.

On July 15, 1923, a nest was found fourteen feet from the ground in the end of an oak limb along a road near the creek. The nest was one and one-half feet from the end of the limb and twenty feet from the main trunk. The brooding female flew off the nest when the limb was hit with a stick, but she stayed in the vicinity and called. The nest was less than half way to the top of the tree.

The earliest record of arrival is April 28, 1923.

Progne subis subis (Linnæus).

Purple Martin. (30.)

A few migrating martins were seen in the spring of each year. In the early summer a few stragglers were seen flying over, but they did not rest on the area. Later they came to the lake to feed and rest, so that in some days in the fall there were many thousands on the lake at one time. They fed on the flying insects that were found over the water and which they caught while on the wing. They were usually in flocks with other swallows.

Although none nested within this area, martins were common through the summer in all the near-by towns.

On September 23, 1922, this species was the most abundant of the swallows which were feeding over the lake. The birds were scattered and flying close to the water until six o'clock in the evening, when they rose and began flying in a dense flock. The north edge of the flock, above the south edge of the lake, appeared to be more dense than any other edge. The flock was at least half a mile long, but not quite so wide. The birds could not be seen distinctly, and were estimated to be about one hundred yards above the ground. The flock kept moving, and the birds continued to mill until 6:30. At this time they started to fly down to the cat-tails below in a compact, dense, and swiftly moving single column of birds which "poured" straight down to the thicket of cat-tails. After about one-third of the flock had gone down the downward flight was stopped for about one minute. Then it continued until about half the remaining birds had gone down. Then the downward flight was again halted for about a minute, after which all the rest of the birds went to roost in the *Typha* in the same manner as the preceding ones had done. Firing a shotgun caused no movement or excitement among the birds. Walking among the roosting birds caused them to rise a little and to fly on ahead a few steps, but they would not leave By this time it was too dark to see them distinctly.

Another peculiar flight habit of this species was noted, which may throw some light on the origin of this complex evening flight. Often, while this and other swallows were feeding near the surface of the water in the daytime, small hawks would fly in and attempt to catch one of the birds. Whenever a hawk came all the swallows would gather into a compact flock, which would rise and fly after the hawk until it retired. Then the birds would return to the lake and begin feeding in the usual manner. The flight which takes place before the birds go to roost at night may have been used so often to escape hawks that it became a habit, and is used even when there is no hawk present.

The earliest spring record for the purple martin is April 19, 1924. September 23, 1922, is the latest that it was seen in the fall.

Petrochelidon lunifrons lunifrons (Say).

Cliff Swallow. (125.)

This swallow was most often seen feeding, with other species of the family, over the water at the lake during the spring, and especially the fall migration seasons. It was nearly always much more numerous in the fall. Usually not so many of this species were present as of the other swallows.

Some were flying over the river on May 10, 1924. The only other spring record is for May 29, 1924, when some were feeding over the lake. In the fall this bird was present from August 24 until September 12, 1923.

Hirundo erythrogaster Boddært.

Barn Swallow. (38)

The barn swallow nested in barns and other buildings in the vicinity. In summer it was seen, in small groups, flying over fields and even over the timber, and sometimes it fed over the water of the lake. Its numbers on the lake increased throughout the summer from the middle of June until the middle of September. This bird rested on telephone wires along the roads, on willow snags around the lake, and on the stems of *Nelumbo* in the lake. Some were seen on the mud south of the lake on September 7, 1922.

On June 9, 1922, a nest was found on the side of a stringer in a barn on the Whittaker farm. It contained young birds. A bird started to build a nest in a hog shed on the E. V. Roundy farm early in the morning of June 8, 1923. It carried mud from a wet place below a near-by spring. The nest was never completed.

A great many barn swallows were feeding over the lake on October 7, 1922. The flock was compact and flew against the strong north wind, in its feeding, until it reached the north side of the lake. Then the whole flock would quickly fly to the south side of the lake and slowly work back to the north. New individuals continued to arrive. Once the flock was disturbed by a hawk.

On October 11, 1924, many small flocks were noted flying south over the lake. When they reached the north side of the lake, the flocks came down to the surface of the water and continued their flight across to the south side, where they rose again and flew on to the south. Some small flocks were seen flying south high over fields on the bluff on October 12, 1924.

On August 30, 1923, and September 10, 1922, this was the most numerous swallow of those feeding over the lake.

The first record for 1923 is April 28; for 1924 is April 21. In 1922 the last fall record is October 7. In 1924 the last fall record is October 12.

Iridoprocne bicolor (Vieillot).

Tree Swallow. (365).

Thousands of tree swallows were sometimes present in the seasons of migration. Of these, a few pairs remained to nest where conditions were favorable. When feeding, this bird was usually found over the water of the lake. Sometimes it fed on the mud at the edge of the water as on September 7, 1922. A few times it was seen feeding over fields on top of the bluff or over the willows on the bar. On June 10, 1922, one was seen flying over the creek. Flocks of this species rested on telephone wires along the roads and in the dead willows in the lake.

This bird was found nesting in the summers of 1922, 1923 and 1924. This is the only record of which I know of the nesting of this species in Kansas.

On June 7, 1923, a nest was found in a hole in a leaning willow stump fifty yards from the edge of the water on the land at the south side of Doniphan lake. The hole was six feet from the ground. The nest was lined with chicken feathers. A female flew out of the nest to a near-by stump where a male came and they mated.

A pair was seen mating on a dead willow on the north edge of the lake on May 30, 1924.

A pair of adults was feeding young birds in a nest three feet above the water in a hole in a willow stump in the north part of the lake on June 12, 1922. On each trip the parent at the nest did not leave until the other one arrived.

On June 13, 1922, another nest, with young which were being fed by adults, was found in another willow stump near the one found on June 12. Another nest was found in a hole in a stump that was two feet above the water. This nest was built of fine strips of bark covered with chicken feathers from one to four inches long. A side of the stump was torn away and the nest, with the five white eggs which it contained, was taken out. An adult returned to the stump and attempted to find the nest. It stayed at the stump for over half an hour. Parents were still feeding young in nests in the willow stumps on June 16.

The presence of water near the nest site seems to be a necessary condition for the nesting of this bird in this locality, since in the season of 1923, when the lake was nearly dry, it did not nest there, but nested at Doniphan lake, four miles away, where there was water. In the spring of 1924 there was water in the lake, and the tree swallow again nested there in the same stumps as in 1922.

Small flocks that were flying south over the lake on October 11, 1924, flew low over the water to feed.

The earliest spring record for this species is April 5, 1924, when one was flying close to the water in the center of the lake. The latest fall record is October 21, 1923.

Riparia riparia (Linnæus).

Bank Swallow. (17)

A small number of bank swallows was present during the summer. The species became much more numerous in the fall. It fed over the water of the lake, over the river, and over the creek. This species was found a few times with other swallows on telephone wires along the roads.

The earliest spring record is May 10, 1924. The latest fall records are for September 10 of both 1922 and 1923.

Stelgidopteryx serripennis (Audubon).

Rough-winged Swallow (37.)

A few individuals were seen frequently during the summer, and they helped make up the large flocks of migrating swallows in the spring and fall. This bird fed over the lake, over the river, over fields and pastures, over the bluff, and, especially in summer, over the water in the creek.

The rough-winged swallow rested on telephone wires and fences along the roads, on drift in the river, and in trees and on snags at the edge of the lake and the creek.

One was seen flying out of a hole in a vertical bank along the creek on June 15, 1922. One was hovering at the entrance of a hole in the bank of the creek on May 18, 1924.

In 1923 the first was seen on April 15. The earliest spring record in 1924 is April 19. The latest fall record is October 20, 1923.

Bombycilla cedrorum Vieillot.

Cedar Waxwing. (7.)

The cedar waxwing was found in groups of from one or two to about one hundred individuals. It was usually found in the tops of the trees on the bluff or on the bar.

The stomach of one that was killed on August 23, 1922, contained a snail and a berry of some wild fruit. Some were feeding on hackberries on March 3, 1923.

This bird was found very irregularly. It was recorded on the following dates: January 29, 1923; March 3 and 30, 1923; April 29, 1923; May 6, 12 and 19, 1923; and May 8 and 12, 1924; June 5, 1923; August 23, 1922; September 7, 1923; and November 30, 1923.

Lanius ludovicianus migrans W. Palmer.

Migrant Shrike. (5)

Migrant shrikes were not found within the area in summer, although the bird nested along the roads through the surrounding farm land. It was usually found in Osage orange or in other thickets along the roads or perched on telephone wires. A group of five or six was seen on the wires along a road two miles west of the area on July 14, 1923.

There are only two records for the seasons of migration. On March 30, 1923, one was eating insects on the ground in a field that was being plowed and on which crows were feeding. On September 2, 1922, one was shot in the brush on the lower part of the bluff at six o'clock in the morning.

Vireosylva olivacea (Linnæus).

Red-eyed Vireo. (58 5.)

Red-eyed vireos were evenly distributed during the summer over the bluff, along the creek, and on the older portions of the bar. This bird was usually found in the tops of the trees. It was heard singing throughout the summer.

A nest was found five feet from the ground in a dogwood on the bar north of the lake on June 7, 1923. It was made of coarse material and contained three eggs and one cowbird's egg. Two adults were perched near by. Another nest was found on the same day seven feet from the ground in a tall maple on the bar east of the lake. It was hanging from a fork of a horizontal limb three-eighths of an inch in diameter and was made of paper and strips of the inner bark of a tree. It contained three eggs. The adult called two or three times from a near-by perch. On June 16 the adult stayed on the nest until it was almost touched. In the nest at this time were one young and two eggs.

On June 28, 1923, a nest was found five and one half feet from the ground in the end of a branch of an oak on the bluff west of the lake. The brooding bird slipped off the nest quietly. In the nest were four eggs and one egg of the cowbird. On July 6 a young cowbird was trampling two young vireos in this nest. There was an unhatched egg in the nest.

An adult was feeding two young cowbirds just out of the nest on August 22, 1923.

A bird was building a nest nine feet from the ground in a box elder on the lower part of the bluff northwest of the lake on June 19, 1922.

Some young birds were calling loudly in a nest fifteen feet from the ground in a tree along the creek on August 23, 1921.

In the fall this bird was one of the most numerous in the flocks of migrating birds which fed in the brush along the lower part of the bluff and in the willows on the bar. Dates of first occurrence in the spring are May 6, 1923, and May 3, 1924. Late fall records are September 10, 1922, and September 14, 1923.

Vireosylva philadelphica Cassin.

Philadelphia Vireo. (1.)

One was collected in the willows on the bar with other vireo and warbler transients on September 2, 1922. Another was shot in the same location on September 24, 1922.

I know of no other records for this species in Kansas, and of no other fall records for it in the Kansas City region.

Vireosylva gilva gilva (Vieillot).

Warbling Vireo. (29.5.)

This vireo was found in considerable numbers in both the spring and fall, but only a few pairs stayed through the summer.

In summer this bird was usually found on the bar near the lake or in groves of medium-sized cottonwood trees. In the summer of 1923 a pair stayed in a group of cottonwood trees near the edge of the bar all summer, but their nest was not located. The bird was sometimes seen in apple trees in orchards.

While migrating this bird fed with other vireos and warblers on the bluff, along the creek, and in the weeds and trees on the bar.

The warbling vireo was first seen in 1923 on May 5, and in 1924 on May 3. In 1922 the last was seen on September 10, and in 1923 on September 15.

Lanivireo flavifrons (Vieillot).

Yellow-throated Vireo. (3.)

One was shot in the timber on the bluff on April 29, 1923. A pair was heard singing on the lower part of the bluff on May 3, 1924 On July 14, 1923, one was singing in the tops of the trees on the bluff west of the north edge of the lake. One was collected on the bluff on August 23, 1921. Another was seen in the willows on the bar with other transients on September 2, 1922.

Lanivireo solitarius solitarius (Wilson).

Blue-headed Vireo. (4.5.)

One was shot in a tree on the bluff on May 6, 1923. Another was shot that was feeding in the brush on the bluff August 29, 1922. Others were feeding in weeds and willows on the bar, along the creek, and on the bluff on September 2, 10 and 24, 1922; September 7, 14 and 15, 1923; and October 7, 1923. Generally only one or two were found together and they were in flocks of small transients.

Vireo griseus griseus (Boddært).

White-eyed Vireo. (29.5)

This vireo was found in the brush along the lower edge of the bluff, at the edge of the timber on the bluff, and in small clearings in the timber throughout the summer. About fifteen pairs nested within the area. The bird was nearly always found near the ground, even when singing.

On June 12, 1922, a pair of adults was seen with food near a large rock at the west edge of the lake. The nest could not be found, although a diligent search was made. On April 8, 1923, the nest was found in a bush of coralberry and two feet from the ground.

A pair with food in their mouths was calling excitedly in some brush in the timber about half way to the top of the bluff on June 29, 1923. The nest was located one and one-half feet from the ground, in the end of a branch of an elm eight feet high. It was partly shaded. Bits of rotted wood were fastened to the outside of the nest in which there was a young cowbird whose wing feathers were one-fourth inch beyond their sheaths. The adults stayed near the nest and called and sang, sometimes on limbs as high as twenty feet. On July 6 adults were feeding a young cowbird on the bluff one hundred yards west of this nest. The nest was empty. On the outside it measured three and one-half inches deep and two and one-quarter inches wide. Inside measurements were two and one-half inches deep and one and three-fourths inches wide. It was lined with fine grasses.

In the fall and in the spring this bird fed with other small transients in the willows on the bar and in the brush on the bluff.

The earliest spring record is May 6, 1923, and the latest fall record is September 13, 1923.

Vireo bellii bellii Audubon.

Bell's Vireo. (45.)

The Bell's vireo is a very characteristic bird of the growths of willow thickets that grow on the newly formed bars along the Missouri river. The type specimen of this species was collected in the bottom lands across the Missouri from where this work was done. (Harris 1919, p. 313.)

In summer this vireo was found in willows on the bar, along fences of Osage orange, in the farm land, and in the fields of sprouts on top of the bluff. During the migrations it joined other small transients that fed on the bar and the lower part of the bluff.

On June 5, 1923, a nest was found five feet from the ground in a small cottonwood east of the mouth of the creek on the bar. It was made of coarse material and held four eggs. The brooding bird flew off the nest when disturbed and began singing in the tree in which the nest was located.

A nest was found two and one-half feet from the ground in a dogwood three feet high near the east edge of the willows north of the lake on June 7, 1923. It was made chiefly of cottony material, with some leaves on the outside and some fine plant material on the inside. The adult, which was brooding three eggs, slipped off the nest quietly, but returned after about two minutes and called. Then it sang.

Three nests were located on June 8, 1923. One was on a lower branch of a dogwood five feet high that was growing east of the lake. It was three feet from the ground, and was shaded by other shrubs and trees. There were four eggs in the nest. The brooding bird left when approached to within twenty feet. Another nest was in the top of a slender willow five feet high, which was surrounded by willows ten to twelve feet high and by some weeds. The nest was made of grass and leaves and was grayish in color. On the outside it measured two and three-fourths inches deep and two and one-half inches wide. There were four sparsely spotted eggs in the nest. No bird was seen on the nest, but one was calling nervously thirty feet away. The third nest was one hundred yards from the second one, and was five feet from the ground in a willow seven feet high. It was hanging from a fork of a branch and was reddish in color. There were three eggs in the nest, but no bird was seen near.

On June 9, 1922, an empty nest was found five feet from the ground in the end of a branch of Osage orange along a lane on the Whittaker farm. No birds were seen. An adult was brooding three eggs in this nest on June 17. The bird left when the nest was approached to within two feet.

A nest was found one and one-half inches from the main trunk of a willow and four and one-half feet from the ground on June 10, 1923. The tree was ten feet high and was growing on a line between the willows and the *Typha* on the south side of the lake. There were three eggs in the nest. A bird was singing near by, but none was on the nest. Another bird was seen building a nest, two and one-half feet from the ground, in a small brushy willow. This was at a point fifty yards from the edge of the willows southeast of the lake.

The earliest spring record is May 3, 1924. The last record for 1922 is September 5; the last 1923 record is September 6.

Mniotilta varia (Linnæus).

Black-and-white Warbler (12)

The black-and-white warbler was usually found in small groups of two or three, which fed on the main trunks and branches of trees on the bluff and about ten feet from the ground in the willows on the bar.

Only two birds were seen in the summer months. A male was feeding on the trunks of trees in a ravine on the bluff on June 10, 1922. Another bird was seen flying through some oak timber north of the lake on June 17, 1922.

In the spring transients were present between April 28, 1923, and May 20, 1923. Migrants were more numerous in the fall, and were found through a longer period of time. They were seen almost daily with other fall transients. The records are between August 23, 1921 and 1922, and September 15, 1923.

Protonotaria citrea (Boddaert).

Prothonotary Warbler. (16.)

A small colony of less than a dozen pairs of this warbler nested in holes in willow snags on the north side of the lake each summer. During the nesting season these birds were rarely found in any other part of the area. Here they flew back and forth from stump to stump singing, feeding, and carrying on other activities of their daily life.

On June 12, 1923, a nest was found four feet from the ground in a willow stump five feet high, at the edge of an open place on the northeast side of the lake. The nest was made of grasses and was built up to within a few inches of the opening. The female, that was brooding four eggs, flew off the nest and sang. A male was singing near by. The opening of the nest hole was irregular and was large. It was two and one-half inches wide and six inches high in its greatest dimensions. The stump was at the edge of the lake bed, but there was no water in sight.

Another nest was found one hundred yards away in a hole six feet from the ground in a stump eight feet high. The opening was two inches in diameter, and the nest was three and one-half inches below the lower edge of the opening. The nest contained eggs, but the number could not be determined. A female that was on the nest flew off when the stump was hit with a stick and attempted the broken wing ruse until she was about thirty feet away, when she flew and began calling more excitedly than had the bird at the last nest. There was grass and *Polygonum* growing around the stump, but there was no water within sight.

A third nest was five and one-half feet from the ground in a nearly dead willow stump seven feet high that stood north of the lake. The opening of the nest hole was one and one-half inches in diameter. The next was three and one-half inches below the opening, and it contained at least four eggs. There was a dense growth of *Polygonum* three feet high around the stump. The brooding female flew off the nest and attempted the broken wing ruse. Both parents called excitedly. There was a chickadee's nest in a similar stump fifteen feet away.

In 1922 there was standing water around the stumps in which the nests were found in 1923. The number of nesting birds appeared to be about the same for both seasons. On June 16, 1922, a nest was found five feet above the water in a hole in a willow stump in the north part of the lake. The nest was made of grass and was two inches below the opening. There were three eggs in the nest. Both the male and the female stayed near. On June 19 both parents were feeding young birds in this nest.

After the end of the nesting season in June very few of these birds were seen until the migration started in August. A female was seen along the edge of the river near the mouth of the creek on June 29, 1923. None was seen in July. In the fall migration it was found from August 3 until September 10 in 1922. At this time of year it fed with other warblers on the bluff and on the bar, but was not found on the nesting ground. It was also found on the bluff and on the bar during the spring migration. The earliest record for the spring is May 5, 1923.

Helmitheros vermivorus (Gmelin).

Worm-eating Warbler (1)

One was singing in the tops of the trees in a ravine on the bluff in the middle of the morning of July 11, 1923. One was shot with other transients in the tall weeds in the edge of the willows on the bar on September 10, 1922.

Vermivora pinus (Linnæus).

Blue-winged Warbler (2)

One was singing in the tops of trees half way to the top of the bluff on June 16, 1923. It moved around within one hundred and fifty yards of where it was first heard

One was found on the lower part of the bluff on August 18, 1923. Another was taken on the bluff on August 26, 1921. One was shot in the willows on September 4, 1922.

Vermivora ruficapilla ruficapilla (Wilson).

Nashville Warbler (95)

This warbler was found during the migrations, sometimes in considerable numbers, as on September 13, 1923, when it was the most common small transient noted. It fed in the tops of the shrubs and the smaller trees on the bluff and in the trees and weeds on the bar and along the creek.

Not so many were seen in the spring as in the fall. May 6 and 12, 1923, are the only spring dates, and only one bird was seen on each of these. In the fall the first was found August 27, 1921; August 24, 1922; and August 23, 1923. It was present until September 24 in 1922.

Vermivora celata celata (Say).

Orange-crowned Warbler. (4.5.)

This warbler was found in the trees on the bluff on April 28, 1923; May 5, 6 and 12, 1923; May 10, 1924; October 6 and 7, 1923; and October 12, 1924. It was usually seen on the lower part of the bluff.

Vermivora peregrina (Wilson).

Tennessee Warbler. (3.5.)

The Tennessee warbler fed with other migrating warblers in weeds and willows on the bar and along the creek and in the trees on the bluff. Usually not many individuals were seen in a single day.

Spring records are between May 6 and 19, 1923. In the fall the bird was found on August 31, 1923; October 8, 1922; and October 11, 1924.

Compsothlypis americana pusilla (Wilson).

Northern Parula Warbler. (17.)

A few pairs of this bird stayed all summer to nest along the lower portions of the bluff, where they were heard singing in the tops of the large and medium-sized trees. They also fed among the branches of these trees. On June 28, 1922, an adult male was seen feeding young just able to fly, in willows on the bar along the lower edge of the bluff and near the mouth of the creek.

During the migrations this bird was found on the brushy, lower part of the bluff and on the bar with other warblers, but chiefly on the bluff. The earliest record for spring is April 19, 1924. The last one was seen, in 1923, on September 13.

Dendroica æstiva æstiva (Gmelin).

Yellow Warbler. (18.)

This is another warbler that was represented in the area in summer by only a few nesting pairs. During the nesting season it was restricted almost entirely to the growth of willows and cottonwoods on the bar. The birds fed and nested in the tops of these trees.

On June 7, 1923, a nest was found eight feet from the ground in a willow on the south side of Doniphan lake. The brooding female returned to the nest, which held five eggs, about five minutes after she was flushed from it. The male stayed near by, but did not move very nervously. The nest was in the same tree with, and five feet below, a nest of the orchard oriole.

A nest was found five feet from the ground in a crotch of a willow twelve feet high on the bar southeast of the lake on June 8, 1928. The nest was made of closely woven grayish material. The outside diameter was larger at the center than at the rim. Inside, there were five eggs. A pair of adults was seen near, but not on the nest. On June 10 the female was on the nest. The male came and called when she was frightened off the nest.

During the migrations this bird was found with other transients on the bluff and along the creek. A few were seen in trees in yards. The first spring record is for April 28, 1923. None was seen in the fall later than September 5, 1922. On August 28, 1923, one was seen, alone, along a fence of Osage orange six miles northwest of the area.

Dendroica coronata (Linnæus).

Myrtle Warbler. (85)

This warbler was found in small flocks in trees in yards, along the bluff, along the creek, and on the bar, both in the spring and fall migrations.

The records for spring are between April 21, 1924, and May 20, 1923. Fall records are from October 20, 1923, to November 8, 1924.

Dendroica magnolia (Wilson).

Magnolia Warbler (1)

One was shot out of a flock of migrating warblers in trees on the lower part of the bluff on May 19, 1923. Another was shot near the same location on May 20, 1923.

Dendroica cerulea (Wilson).

Cerulean Warbler (1)

One was seen in a tree in a ravine on the bluff on June 13, 1922. Another was singing in the middle branches of a medium-sized tree along a road on the lower part of the bluff on June 26, 1922.

Dendroica striata (J. R. Forster).

Black-poll Warbler. (5)

One was collected from a small flock of migrating warblers that was feeding in the trees in a farm yard on the evening of August 27, 1923.

Dendroica fusca (Müller).

Blackburnian Warbler (5)

One was shot in a medium-sized tree on the lower part of the bluff on September 3, 1923.

Dendroica virens (Gmelin).

Black-throated Green Warbler. (1.)

One was taken in the top of a tree along the creek on August 28, 1923, and another was found in a flock of migrating warblers along the creek on September 13, 1923.

Dendroica vigorsi (Audubon).

Pine Warbler. (.5.)

One was shot out of a flock of other warblers in the top of a tree along the creek on September 13, 1923.

Seiurus aurocapillus (Linnæus).

Ovenbird. (3.)

In the spring and fall the ovenbird was found near the ground on the lower part of the bluff and on the bar with small transients. No evidence of its nesting was found. One was singing near the ground on the lower part of the bluff on May 4, 1924. The only other spring record is for May 20, 1923. Fall dates of occurrence are between August 9, 1922, and September 14, 1923. On the last date several were seen in willows on the bar.

Seiurus noveboracensis notabilis Ridgway.

Grinnell's Water Thrush. (8.5.)

Grinnell's water thrush was found singly at the edge of the lake, along a slough on the bar, and at the edge of a pool below a spring. Sometimes it was found in patches of *Nelumbo* or of *Typha* growing in moist or wet soil at the edge of the lake.

On May 6, 1923, one flew into a yard from the bar and called once or twice. Then it flew back among the trees on the bar where it was lost. Spring records are between this date and May 19, 1923. One was seen at a spring north of the lake on May 11, 1923. Two were seen along the creek on May 18, 1924.

In the fall this bird was more restricted to the vicinity of the lake than in the spring. Migration records are between August 21 and September 4, 1922.

Seiurus moticilla (Vieillot).

Louisiana Water Thrush. (.5.)

A pair was seen along a branch of the creek near the west edge of the area on April 20, 1924.

Oporornis formosus (Wilson).

Kentucky Warbler. (27.5.)

Kentucky warblers were rather unevenly distributed over the bluff and along the creek during the nesting season. They were found in those places where the undergrowth was dense, or where there was a canopy of shade overhead. These birds spent most of their time on the ground. Nesting pairs became very nervous when their territory was entered, and would often call excitedly when certain sections of the timber were disturbed.

One was seen bathing in water below a spring on June 14, 1922. On May 6, 1923, several were flying and chasing each other on the side of a ravine on the bluff. Some of them sang from trees.

On June 30, 1923, a nest was found on the ground between two weed stalks that were seven inches apart. It was made of sticks and leaves and was lined with finer material. Both parents were carrying food in the morning. The nest was not found until 4:30 in the afternoon. The brooding female ran out on the ground, with drooping wings, when she was approached to within two feet. She ran about ten feet and then flew. , During the hour and a half that the search for the nest was made, the male stayed within twenty yards of the nest and called excitedly. Once he brought food but ate it himself. He stayed in the trees, and twenty or more feet from the ground. The male was chased away from one small tree several times by a brooding female humming bird which had a nest there. These birds used two call notes, one of which was much more harsh than the other. In the nest were two young with their wing feathers still in the sheaths. The yellow color below showed plainly. On July 2 the nest and young birds were gone and one of the supporting weeds was broken. The parents were still in the vicinity, but they were not nearly so nervous as they had been two days previously.

In the spring and the fall this warbler joined other members of the family in migrating flocks that moved and fed over the bluff, along the creek, and on the bar.

The first spring record is for April 29, 1923. In the fall this species was found as late as September 14, 1923.

Oporornis philadelphia (Wilson).

Mourning Warbler. (8.)

During the years when this study was made the mourning warbler was much more common at this point on the Missouri river than it has been found to be by observers in other parts of the valley in other years. Because of its reported scarcity in other parts of the valley all the records for this area are given here.

On May 19, 1923, at least twenty-five, most of them males, were seen near the ground in willows on the bar and along the lower edge of the bluff. On May 20, 1923, this was the most numerous of the migrating warblers. It was found on May 10, 17, 29 and 30, 1924. Fall dates are August 23 and 24, 1921; August 29 and 31, 1922; September 2, 4, 7 and 10, 1922; and September 13 and 14, 1923. The bird which was taken on August 29, 1922, was bathing at a spring on the lower part of the bluff. Others were found near the ground on the bar and on the bluff.

Geothlypis trichas trichas (Linnæus).

Maryland Yellowthroat. (23.)

A few pairs of this yellowthroat nested on the ground studied. They were found in weedy and grassy growths near water on the bar and along the creek. One was found at the edge of the timber on top of the bluff on July 6, 1923.

On June 7, 1923, a nest was found in sedges north of the lake. It was built on dead plants six inches from the ground and was partly shaded. The top was open. The female, which was brooding five eggs, flew silently away when she was flushed.

Another nest was found in sedges on the bar north of the lake on June 12, 1923. This nest was one foot from the ground. It contained three young with feathers, one unhatched egg, and one cowbird's egg. Both parents were seen near by with food, but they would not go near the nest for about half an hour. The female stayed about twice as far away from the nest as the male, and both called excitedly. The young were not out of the nest on June 16. The cowbird's egg was still in the nest and the male was calling near by.

On June 12, 1923, a nest was found in grass growing two and one-half feet high northeast of the lake where there was a scattered growth of *Typha*. The ground had been burned over during the preceding winter. The female was brooding five eggs. She did not flush from the nest until she was almost touched.

In the migration season this species joined other warblers on the bar and on the bluff, but it was nearly always found near the ground. The earliest spring record is May 3, 1924. September 14, 1923, is the latest fall record.

Icteria virens virens (Linnæus).

Yellow-breasted Chat. (34.)

Chats were found daily throughout the summer. They were found wherever there were thick tangles of undergrowth in the timber on the bluff, on the bar, in pastures, in cleared land, and in timber along the creek. Usually they kept near the ground and were hard to locate except by their call.

Several times in the summer this bird was found bathing at a spring or in water below the spring. On May 12, 1923, one sang as it flew from the bar to the bluff and accompanied the song by a peculiar jerking of the tail.

A nest was found on June 5, 1923, that was two and one-half feet from the ground in a willow about four feet high on the south side of the lake. One bird was sitting on three eggs in the nest and another was perched in the top of a small tree ten yards away.

On June 8, 1923, a nest was found two and one-half feet from the ground in a fork of a willow five feet high that was south of the lake. The nest was made of grass and was nearly as coarse as the usual red-winged blackbird's nest. It was about four inches in outside diameter. There were three eggs. The brooding bird did not leave the nest until it was approached to within five feet.

In a clearing on the bar north of the lake a nest was found two and one-half feet from the ground in a rosebush on June 12, 1923. This clearing had grown up in *Equisetum* which was three feet high. The nest was partially shaded by the rosebush, but not by trees. There were four young in the nest, the largest of which had a V-shaped patch of down which ran from the top of the wings. The brooding adult flew off the nest when approached to within thirty feet and called in the vicinity.

On June 12, 1923, a nest was found two and one-half feet from the ground in a clump of coralberry. This was in an opening on the bluff. No bird was seen, but there was one egg in the nest and one cowbird's egg. There were no more eggs on June 13. On June 18 there were three chat's eggs and one cowbird's egg, and an adult, which left when approached to within three feet, was sitting on them. There were young birds in the nest on June 28. Neither parent was seen near the nest when it was visited on July 2. One of the young birds opened its mouth for food. The nest was empty on July 10.

On June 13, 1923, a nest was found three and one-half feet from the ground in a dogwood which was growing in an unplowed field on top of the bluff. In the nest were three newly hatched young and one egg. Neither parent was seen.

A nest was found with four eggs on June 16, 1923, that was five and one-half feet from the ground, in the top of a small grapevine which grew on the side of a cottonwood fifteen feet high. The tree was in the *Equisetum* north of the lake on the bar. The outside of the nest was made of leaves and coarse stems. The brooding bird left when approached to within eight feet, and then called from a distance. On the same day another nest, with four eggs, was found in a grapevine on a small dead willow stump on the bar north of the lake. The brooding bird left this nest silently and flew near the ground when approached to within ten feet.

A nest was found in a field of sprouts on top of the bluff west of the lake on June 29, 1923. It was four feet from the ground and contained five eggs. Both parents came and called much like catbirds.

The latest date on which an occupied nest was found was July 19, 1923. The nest was three feet from the ground in a thistle in a patch of weeds between the willows and a cornfield on the bar. It was partly shaded and contained four eggs. The brooding female left the nest when approached to within five feet. A male was singing near by.

A chat was seen in a hedge fence along a road near the creek on September 6, 1923. Two were seen in willows on the bar on September 5, 1922. One was shot in some weeds along a slough on the bar on August 31, 1922 A female that was shot on August 27, 1921, had eaten a large number of pokeberries. These are the only records for the occurrence of this species in the fall. Very few were seen in July or August.

May 6, 1923, is the earliest record for the spring.

Wilsonia pusilla pusilla (Wilson).

Wilson's Warbler. (11.5.)

Wilson's warbler was found frequently in migrations, and was present in varying numbers from one or two up to about fifty individuals, which is the number found on September 6, 1922, when this species was the most common warbler in the area.

It was found feeding and moving through the tops of the trees on the bluff, on the bar, and along the creek, usually within ten feet of the ground. In the spring this warbler preferred the bluff for a feeding ground, and in the fall it preferred the willows and growths of weeds on the bar and along the creek.

In the spring this warbler was found between May 10, 1924, and May 19, 1923. The period of migration for this species extended over a longer period in the fall, and the birds were found from August 23, 1921, and August 25, 1922, until September 10, 1922, and September 14, 1923.

Wilsonia canadensis (Linnæus).

Canada Warbler. (2.)

A Canada warbler was seen in low bushes on the bluff north of the lake on May 20, 1923.

Two were collected near a spring along the lower edge of the bluff on August 23, 1921. On August 24, 1921, one was taken in the willows on the bar. One was shot in a thick growth of willows on the bar on August 27, 1923. Weeds were thick under the trees at this place.

Setophaga ruticilla (Linnæus).

Redstart (19)

Several pairs of redstarts stayed all summer along the bluff and on the bar, but no nests were found. They fed and sang in the tree tops, especially along the roads on the bluff, throughout the month of June. On July 6, 1923, one flew to an oak sprout in a field on top of the bluff.

On August 30, 1922, one became entangled in a spider's web in some bushes on the lower part of the bluff and was struggling to free itself, when a gun was fired near by, which caused it to put forth greater exertions, and by so doing to gain its freedom.

During the season of migration this bird was found on the bluff and in the weeds and willows on the bar and along the creek. In the spring it arrived in April (April 28, 1923). It was most numerous from the middle of August until the middle of September. On September 10, 1922, this was the most abundant transient warbler that was feeding on the bar. Most of the redstarts were feeding about fifteen feet from the ground. September 15, 1923, is the latest fall record for this species.

Mimus polyglottos polyglottos (Linnæus).

Mocking Bird. (1.)

One was seen along a road eight miles from the area on June 24, 1922, and there is one record for the area on August 23, 1921.

Dumetella carolinensis (Linnæus).

Catbird. (36.)

The catbird was not found over the whole area in summer, but it was common in those portions where the amount and character of the cover of plants was suited to its habits. In summer this bird was found along the creek, in orchards, in thickets on the bar and on the bluff, and in fields of sprouts. It was frequently seen on or near the ground in farmyards.

One was seen carrying a ripe cherry near Doniphan lake on June 25, 1922. Another was eating a large insect in the creek bed on July 18, 1923.

A nest was found six feet from the ground in a small elm on the creek bank on June 10, 1922. The nest, which contained one egg, was well shaded.

On June 7, 1923, a nest was found four feet from the ground on the side of a willow tree at the edge of Doniphan lake. The nest contained one egg. An adult was calling near by.

On June 22, 1923, a nest was found three feet from the ground in a gooseberry bush in a small pasture near the creek. The nest was empty. Remains of a young bird, with wing feathers which projected one-half inch beyond their sheaths, lay on the ground. The bird had been partly eaten by some animal.

A bird was seen carrying nesting material on June 25, 1923. Its nest was found on July 3. It was nine feet from the ground in the center of an apple tree in an orchard. An adult was brooding three eggs. Both birds of the pair called near by.

In the spring and fall catbirds joined other small birds to feed on the bluff, on the bar, and along the creek. The first in the spring was seen on May 6, 1923. October 7, 1922, is the latest record in the fall.

Toxostoma rufum (Linnæus).

Brown Thrasher. (31.5.)

The brown thrasher was found in thick growths of shrubbery along the roads, along the creek, on the bluff, and on the bar. It usually fed and spent most of its time in the brush near the ground, but it sometimes selected a perch on the highest branch of a tall tree from which to sing.

On May 29, 1924, a nest was found four feet from the ground in a gooseberry bush in a small brushy pasture near the creek. No bird was seen near, but there were two eggs in the nest.

An adult was brooding three eggs in a nest six feet from the ground in a vine which was growing over a dead stump on the lower part of the bluff on June 13, 1923. There were young in the nest on June 26. One parent was on the nest and the other was near by. This nest was empty on July 5. Another nest was found on July 5 that was seven and one-half feet from the ground, on a leaning trunk of a small dogwood fifteen yards west of the empty nest. There were two eggs in this nest and a pair of adults calling from near by.

On June 20, 1922, a nest was found five feet from the ground in an Osage orange along a road. It contained three eggs. A pair of adults was near.

A bird was brooding four eggs in a nest six feet from the ground in a plum thicket near Doniphan lake on June 22, 1922. It did not leave until the nest was touched.

An empty nest was found four feet from the ground between two cottonwood trees on the bar on June 29, 1923. A pair of adults was seen near, one of which had a caterpillar in its mouth. On July 4 the nest contained one egg. An adult was brooding on July 6.

On June 30, 1923, a nest was found five feet from the ground in the brushy top of a dead, fallen apple tree in a dogwood thicket at the edge of a small clearing on the bluff. An adult, which was brooding four eggs, did not move until the bush was touched. It then called from a near-by perch.

A nest was found three feet from the ground in an oak sprout five feet high in a pasture on top of the bluff on July 18, 1923. A parent was brooding two recently hatched young and one egg. The nest was rather shallow. The sprout was surrounded by sprouts and sweet clover.

Brown thrashers were found scattered through flocks of smaller transients in the fall. The earliest spring record is April 14, 1923. In the fall none was seen after October 7, 1922.

Thryothorus ludovicianus ludovicianus (Latham).

Carolina Wren. (89.)

The Carolina wren was present throughout the year in all parts of the area that are timbered. It chose especially those places where the undergrowth was thick or where there were piles of brush, logs, or of some other kinds of trash. It usually fed near the ground and was found in pairs or singly. This bird sang throughout the winter.

A female was building a nest in a hole in a bank at the edge of a small opening in the timber on the bluff on April 28, 1923. She made about one trip a minute after material, which she got from a place on the ground and about ten yards away. She went to the nest by the same route each time. The male was singing in the top of a small tree twenty feet away. It left when disturbed, but returned six minutes later. On May 12 there was one wren's egg and one cowbird's egg in the nest. An adult was brooding.

Another nest was found in a hole in a bank on April 28, 1923. This one was at the side of a road near the creek, and contained young which the parents were feeding. The nest was empty on May 5.

On May 13, 1923, a nest was found in a hole in a cut at the side of a road near the E. V. Roundy house. The hole was about a foot deep and did not run straight. An adult was sitting closely upon four eggs. By May 19 two of the eggs had hatched, and on May 20 three were hatched. On April 21, 1924, an adult was flushed from a nest in the same hole. There were young birds in the nest on May 3 and 8, but the nest was empty on May 17.

A nest was found in a hollow stump nine inches high and eight inches in diameter on the bluff on June 21, 1922. The nest was roofed over and was made of moss, leaves and grass. In the nest were four young and one egg. The brooding bird left immediately when disturbed and did not return for five minutes. Then she left again and returned in another five minutes. No sound was made by the parent bird. Only one adult was seen.

On August 28, 1923, a nest was found in a washed-out hole in a vertical bank of the creek. It was ten feet above the bed of the creek and six feet below the top of the bank. The nest contained partly feathered young birds. One parent brought food, called a few times, and left.

Empty nests were found on tops of stumps, in bridges, and in the tops of sheds. One was seen feeding two young cowbirds on June 17, 1922. Family groups were frequently seen along the bluff at various times during the summer.

Troglodytes aëdon parkmanii Audubon.

Western House Wren. (49.5.)

Several pairs of this wren spent the summer around the various groups of farm buildings on the area. A few were found on the bar, in orchards, and along the creek during the summer. The birds stayed close to their nesting sites.

A pair was seen at the opening of a tin-can nest that was nailed to the side of a garage, on May 6, 1923. Parents were feeding young birds in this nest on June 13 and 14. Two were singing in the dead willow stumps northeast of the lake on June 12, 1923. A partly built nest was found in a hole in one of the stumps. It was five and one-half feet from the ground.

Adults were feeding young in the cornice of a schoolhouse on June 14, 1923.

On June 17, 1923, one was cleaning out material from a hole in a dead limb ten feet from the ground in a box elder in a yard. This was at 5:30 in the evening. The bird was taking out feathers and sticks and dropping them to the ground near the hole. Once it became entangled in a straw, but its extra exertions caused it to free itself.

One flew into a hole in a partially dead apple tree that was twelve feet from the E. V. Roundy house and eight feet from the ground, on July 7, 1923. The bird would not leave the nest when the tree was hit. Another was singing in the same tree.

On July 11, 1923, one was sitting on five eggs in a crevice in a porch. Later in the season the young birds from this nest were killed by a cat.

In the fall this bird joined small transients in the weeds on the bar, along the creek, and on the bluff. Then it was found singly or in small groups and it fed near the ground.

April 19, 1924, is the earliest record and October 11, 1924, is the latest record in the fall for this species. Birds that were seen in the fall were not plentiful and they were usually silent.

Nannus hiemalis hiemalis (Vieillot).

Winter Wren. (2.5.)

One was seen in a thick growth of grass and *Typha* along the north edge of the lake in the morning of March 3, 1923. It was very restless and stayed near the ground. On February 5, 1924, two were seen along the road on the lower part of the bluff. Another was found in the same location on November 17, 1923. On October 24, 1924, one was found on the lower part of the bluff north of the lake. It was shot, and in its stomach were found parts of seeds and small insects.

Cistothorus stellaris (Naumann).

Short-billed Marsh Wren. (.5.)

One that was singing was shot in the grass and weeds south of the willow snags north of the lake bed on May 12, 1923. It was close to the ground.

Telmatodytes palustris iliacus Ridgway.

Prairie Marsh Wren. (8.)

Several pairs of this wren spent the summer in the growth of *Typha latifolia* that grew in and around the lake. More were found in the fall than in the spring.

On May 30, 1923, several empty nests were found in *Typha* in the lake, and the adults were singing near by.

On June 12, 1923, one was found in weeds along a fence north of the lake on the dry part of the bar.

On August 21, 1922, an adult and young, which had no tail, were found in the *Typha* south of the lake. On August 28, 1922, a young bird with tail feathers about half grown was shot south of the lake. Singing birds were seen on September 10, 1922.

In the spring this bird was found in the marshy, wet places below the springs at the edge of the bar. The earliest spring record is April 28, 1923. None was seen in the fall after October 8, 1922.

Certhia familiaris americana Bonaparte.

Brown Creeper. (11)

Brown creepers were found feeding on the trunks of trees on the bluff, on the bar, along the creek, in orchards and in yards, throughout the winter. They were found singly or in small groups, which were usually scattered, and with larger groups of other birds that moved through the timber feeding.

On November 3, 1923, one moved over the surface of a log, a fence post and the trunk of a tree in turn. Some that were feeding on January 31, 1924, spent about half their time on the ground.

This species was noted in the fall on October 28, 1922; October 21, 1923; and October 24, 1924. The latest spring record is April 15, 1923.

Sitta carolinensis carolinensis Latham.

White-breasted Nuthatch. (10)

Although this bird was probably present throughout the year, it was most numerous during the winter months, when it was found in the timber along the creek and on the bar. A few were seen on the bar in willows. It was found singly or in small groups of less than four individuals, and could nearly always be located by its call. Some that were found along the creek on November 17, 1923, spread their wings and tails and called when near each other.

Sitta canadensis Linnæus.

Red-breasted Nuthatch. (3.)

This nuthatch was found feeding with flocks of sparrows in weeds on the bar and along the creek and in trees along the creek in the winter. Usually from one to three were seen on each occasion.

Three were seen together on November 3, 1923. Others were seen on January 12, 1924; February 1 and 4, 1924; March 16, 1924; and April 20, 1924.

Bæolophus bicolor (Linnæus).

Tufted Titmouse. (90.)

The tufted titmouse was found wherever there were trees in the area. Pairs were evenly distributed during the nesting season. Several were found in nearly every day's work. It fed among the branches of the trees. On April 14, 1923, one brought a moth to a limb of a small tree and after holding it for a few seconds fed it to another adult.

A family of young was found with their parents along the creek on June 15, 1922. An adult was feeding young in a hole in a natural cavity of a tree at the edge of the E. V. Roundy yard on May 19, 1923. The nest was four feet from the ground.

On June 16, 1923, a nest was found five and one-half feet from the ground in a hole in an oak tree on the bluff which was ten inches in diameter. The brooding adult did not fly out when the tree was pounded, but left when its mate called from near by. There were five eggs in the nest. The hole was six inches in diameter, and was filled with leaves and fur up to the lower edge of the opening. The opening was irregular and was ten inches high by two inches wide. The nest was empty on June 28.

A nest was found in a natural cavity in a redbud near the top of the bluff west of the lake on June 28, 1923. The trunk of the tree was six inches in diameter and the hole was three inches in diameter. The top of the nest was seven inches below the bottom of the opening. In the nest were five young with wing quills one-eighth of an inch long. One of them opened its mouth for food. Both parents called in a near-by tree. The nest was empty on July 6.

A pair was seen carrying nesting material on April 19, 1924. They were flying along the creek.

In August and September birds of this species joined the flocks of small transients which fed in the timber. Flocks of variable size, but not large, were to be found through the winter until the warm weather of early spring, when the pairs were again distributed through the timber.

Penthestes atricapillus atricapillus (Linnæus).

Chickadee. (98.5.)

The chickadee was one of the most common birds of the area, being found nearly every day that records were kept. This bird was found over all types of the land where there was sufficient vegetation for it. It fed in the trees and shrubs in the timber, and even in the brush and weeds near the ground.

On April 14, 1923, a pair was carrying material from a hole in the underside of a limb in a tree on the bank of the creek. The birds always perched on a near-by weed before entering the hole. On each trip they carried the material to a different place before dropping it. Sometimes both birds were in the hole at the same time. An adult was flushed from the nest on May 12. Both birds called nervously.

A chickadee made several trips to a hole in a stump on the lower part of the bluff on April 15, 1923. On each trip it came out and dropped something from its bill. Several feathers were lying scattered around the stump on the ground. On April 28 an adult could be seen on a nest in the hole, but it would not flush from the stump. On May 12 the adult flew off the nest when a finger was poked into the hole and, with its mate, called nervously.

A pair was working at a dead stump on an elm along a road on May 13, 1923. They were flying alternately to a hole ten feet from the ground. One was heard picking at wood on the inside. After picking a few minutes it flew with some pieces of wood in its bill which it dropped from a near-by branch. This was repeated several times. A pair was seen carrying material to a hole in the top of a fence post along a road on May 19, 1923.

A nest, with five young nearly ready to fly, was found in a hole five feet from the ground on June 7, 1923. It was in a willow stump on the bar on the north side of the lake. The nest was made chiefly of rabbit fur. An adult came with a caterpillar in its mouth and called.

An adult was brooding at least three eggs in a nest in a dead willow stump on the north side of the lake on June 8, 1923. When the stump was hit with a stick the bird flew off and called excitedly.

On June 12 the sitting bird flew off this nest when it was approached to within ten feet.

'A pair was seen feeding young in a nest in a hole fifteen feet from the ground in a dead cottonwood stump along a road on the bluff on June 9, 1922.

In the fall and in the winter chickadees joined flocks of small birds that fed through the timber in the trees and in the weeds. They were nearly always a part of these flocks, and were not often seen, except with other birds, in those seasons.

Penthestes atricapillus septentrionalis (Harris).

Long-tailed Chickadee.

Two chickadees that were collected on February 18, 1923, belonged to this form.

Regulus satrapa satrapa Lichtenstein.

Golden-crowned Kinglet (13)

The Golden-crowned kinglet was found singly or in small groups on the bluff, on the bar, and along the creek during the winter. It fed among the branches of the trees and in the weeds near the ground. On January 31, 1924, one was feeding on the ground at the edge of a pool along the creek. One was feeding in bunches of grass along the creek on January 15, 1924. In especially stormy weather these birds preferred to stay in the branches of coniferous trees where there was more protection from the wind than in the bare deciduous branches

October 20, 1923, is the earliest fall date of occurrence and April 7, 1923, is the latest record for the spring.

Regulus calendula calendula (Linnæus).

Ruby-crowned Kinglet (13.5)

This kinglet was found in about the same types of habitat as its near relative, but it was present in a little greater numbers and at slightly different seasons.

Although this species nests much farther north than does the last, it arrives at this area earlier in the fall and leaves later in the spring, and it was not found in this region in winter. Fall records are between September 14, 1923, and October 29, 1922. In the spring it was found from March 30, 1923, until May 12, 1923.

Polioptila cærulea cærulea (Linnæus).

Blue-gray Gnat Catcher. (40.5.)

This bird was found commonly in the timber on the bluff in the summer. It usually fed in the tops of the trees and the higher shrubs.

On June 4, 1923, a nest was found in a walnut tree along a road on the bluff. Material was being added to the outside of the nest which had just been started on a limb twenty feet from the ground. Both the adults scolded vigorously when a red-eyed vireo came near, and they continued to do so until the vireo left. Another nest that was nearly finished was found two-thirds of the way to the top of an oak along a road on the same day. Both birds of the pair were calling in the tree.

A sitting bird flew off a nest twenty-five feet from the ground in an elm tree along a road on June 6, 1923.

A pair was building a nest two feet below the top of an oak tree twenty feet high on June 12, 1923. The tree was on the bluff. The nest was on top of a limb five-eighths of an inch in diameter. Both birds of the pair brought material and added it to the nest. Each stood in the center of the nest and added the new material to the outside by drawing the bill upwards from the branch. The birds called occasionally while working on the nest.

One was seen carrying nest material on June 14, 1922. On this day one tried to chase a hawk out of a tree on the bluff. One flew after a blue jay on the bluff on June 26, 1923.

During the season of migration this bird was also found along the creek and on the bar in the trees. The earliest spring record is April 19, 1924. In the fall of 1922 this bird was found as late as September 1, and in the fall of 1923 it was found as late as September 15.

Hylocichla mustelina (Gmelin).

Wood Thrush (48.)

Wood thrushes were seen daily throughout the summer, and were distributed over the parts of the area more suitable for nesting. They were usually found feeding on or near the ground in the timber where the shade was rather dense, either on the bar, along the creek, or on parts of the bluff. Early morning and late evening were the times of day at which there was greatest song activity. They usually sang from low perches, but sometimes selected the tops of trees, and even the tops of dead trees, where they were conspicuous for their evening songs.

On June 4, 1923, a nest was found nine feet from the ground on a lower limb of a linden tree on the bluff. The outside of the nest was made chiefly of leaves. The sitting adult did not leave until it was touched with a stick. Another nest was found twelve feet from the ground in a small elm tree in a shaded ravine on the bluff. The bird left the nest when the tree was shaken.

A nest was found twelve feet from the ground in a lower limb of a large elm tree on the lower part of the bluff on June 12, 1923. The brooding bird clucked as it left the nest when the limb was hit. Another nest was found on the lower limb of an elm tree along the lower edge of the bluff on the same day. This one was twenty feet from the ground, and was two-thirds of the way to the top of the tree. The brooding bird left the nest but stayed near by and called from limbs that were fifteen or twenty feet from the ground.

A bird was seen carrying food on June 16, 1923. A pair was seen feeding young on the lower part of the bluff on June 26, 1923. Another pair was found, with young birds just out of the nest, on the bluff on June 29, 1923. Adults were seen feeding young cowbirds on June 30 and July 5, 1923.

On July 4, 1923, a nest was being built six and one-half feet from the ground in a dogwood on the side of a ravine on the bluff.

On July 14, 1923, a nest was found eight feet from the ground on a lower horizontal limb of an oak tree on the side of a hill and along a road. An adult was brooding. On July 19 the nest contained two thrush's eggs and two cowbird's eggs.

An adult was flushed from a nest next to the main trunk of a willow and eight feet from the ground on August 2, 1922. The nest was fifty feet from the creek on the bar.

An adult was brooding three eggs in a nest seven feet from the ground in a dogwood half way to the top of a ravine on the bluff on August 9, 1922. The bird left the nest reluctantly and fluttered near by. The nest was shaded. Another bird that was near by kept up a low clucking.

During the migrations this thrush was often found singly with small birds that were feeding near the ground on the bar or on the bluff. The earliest record of occurrence is May 3, 1924. None was seen later than September 15, 1923.

Hylocichla aliciæ aliciæ (Baird).

Gray-cheeked Thrush. (1.5.)

Gray-cheeked thrushes were collected near the ground on the lower part of the bluff on May 12, 13 and 20, 1923.

Hylocichla ustulata swainsoni (Tschudi).

Olive-backed Thrush. (2.5.)

All the records for this bird are of transients that were seen near the ground on the lower part of the bluff from May 6 to May 20, 1923, and from May 3 to May 30, 1924.

Hylocichla guttata pallasii (Cabanis).

Hermit Thrush. (.5.)

A hermit thrush was seen on the lower part of the bluff on April 6, 1925.

Planesticus migratorius migratorius (Linnæus).

Robin. (68.5.)

Several pairs of the robin were found in summer in farm yards and in orchards near houses. A few were found in timber along the creek. Few were present during the winter, and they were usually in sheltered places in the timber on the bluff or along the creek.

Some flocks were seen feeding on hackberries on February 17 and 18, 1923. On March 30, 1923, about fifty were feeding on the ground in a burned-over clover field. One picked a berry from a rosebush on the lower part of the bluff on March 31, 1923. One was feeding on the ground in a plowed field near the creek on April 14, 1923. A robin was feeding on the ground in a freshly cut alfalfa field on June 5, 1923. Some were eating pokeberries on November 4, 1923, and on February 7, 1924, one was feeding on sumac that was growing at the side of a road.

On February 17, 1923, a flock was found roosting in the tops of some rather exposed small trees along the edge of the bluff. Robins were often seen perched in the tops of tall trees. From these perches they called and sang.

An adult was sitting on four eggs in a nest twelve feet from the ground in the center of a box-elder tree in a yard on May 13, 1923. When it was disturbed the bird called loudly. Another came, and both appeared to be very nervous. One of the pair was standing on the edge of the nest on May 19.

A robin was seen carrying straw to start a nest in a maple tree in a yard on June 7, 1922. The nest was nearly finished by evening. On June 8, 1923, a bird was building a nest in the top of a maple tree in a yard. It brought some of the material from a point at least one hundred and fifty yards away from the nest.

One adult was feeding another on June 16, 1923.

Although the species was present throughout the year, there was a noticeable movement of robins in the migrating seasons. They flocked with the small transients that fed on the bar and on the bluff. Flocks were frequently seen flying high down the creek valley or in some other direction in the evening of days in the winter or in a migration season.

Sialia sialis sialis (Linnæus).

Bluebird. (435.)

Bluebirds were found in summer in orchards, in small clearings on the bluff, on the bar, in pastures where there were trees, and along roads and fences between fields. Nesting pairs were scattered, because they required a suitable cavity in which to place their nests. A pair was seen in the center of a cornfield in which the corn was three inches high, on June 12, 1923. A large flock was found in a pasture on July 14, 1923. Some were feeding on the ground. Some were in living and dead trees, and some were perched on the tops of fence posts. The number of individuals present in the winter, when they were usually found in small groups of four or five, was smaller than at other seasons.

On April 1, 1923, one brought a large insect to a female which was on a limb of a stump along a road. The female took the insect and the pair flew across the road together. A nest was built in the stump, but it was never used. A pair was seen at a hole in a partially buried tree trunk in the creek bottom on April 14, 1923. The female was in the hole most of the time, while the male was perched on a weed two feet away or at the entrance of the nest hole. Both left and returned to the tree several times. The male was calling. On April 28 the female was brooding and would not leave the nest when the trunk was pounded. The male was perched on top of a tree fifty yards away. On April 29 the female left the nest when it was approached to within six feet. The male was seen carrying a caterpillar near the nest on May 12.

A family of young birds, just out of the nest, was found with adults along a slough on the bar on May 30, 1924.

A female was sitting on five eggs in a nest in a post along a road on June 17, 1922. The nest hole was six feet from the ground. Another nest was found in a post near Doniphan lake on June 7, 1923. This one was three feet from the ground and it contained three eggs.

A nest was found in an apple stump near a road on the lower part of the bluff on June 11, 1923. The nest was seven feet from the ground. A female flew out of the hole when the stump was hit. The nest was four inches below the opening. Its contents were not determined. On June 22 the pair was feeding young in the nest. Young birds were heard calling in the nest on June 28. On June 30 the nest was empty.

A nest was found on July 1, 1923, that was four feet from the ground in a fence post between a pasture along a creek and a cornfield. The nest was made of grasses, and was four inches below the opening. It contained four eggs. There was a bird near, but none on the nest.

Small flocks of the size of family groups were found together from the time the first young left the nest in summer until they were separated into pairs in the following spring.

BERKELEY, CAL., January 15, 1928

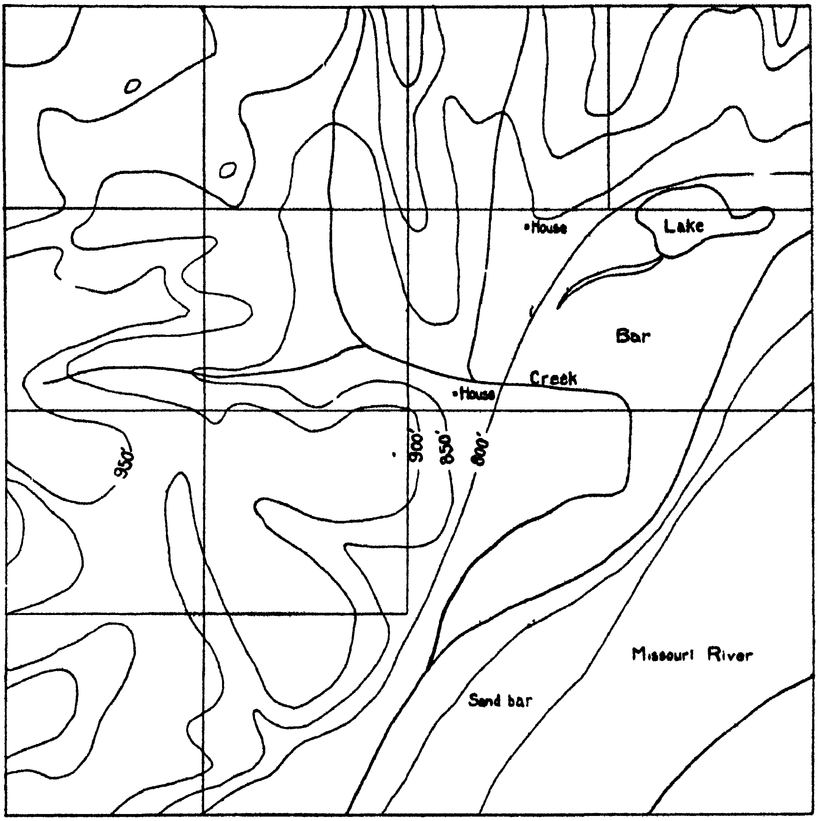

FIG. 1. Map of the area studied. The 800-foot contour line roughly marks the division between the bluff and the river bottom. Scale: one inch equals one mile.

TABLE OF THE OCCURRENCE OF EACH SPECIES BY MONTHS AND BY HABITAT DIVISIONS.

NAME OF BIRD.	Month.												Habitat divisions.																
	January	February	March	April	May	June	July	August	September	October	November	December	River	Creek	Lake	Lake shore	Typha	Slough	Salix-Pop.	Creek timber	Bluff	Timber edge	Sprouts	Orchard	Road	Pasture	Field	Yard	Building
Pied-billed grebe				+	+			+	+	+	+				+														
Herring gull		+	+	+	+	+							+		+	+													
Ring-billed gull				+		+							+		+	+													
Franklin's gull				+	+						+		+														+		
Bonaparte's gull											+		+																
Forster's tern					+			+							+														
Least tern						+	+	+	+				+		+	+													
Black tern					+	+		+	+						+	+													
Double-crested cormorant					+										+														
White pelican				+	+				+	+			+																
Merganser	+	+	+	+							+		+		+														
Red-breasted merganser											+		+																
Mallard	+	+	+	+	+	+		+	+	+	+	+	+	+	+														
Black duck											+		+																
Gadwall			+								+				+														
Baldpate			+							+			+					+											
Green-winged teal			+	+						+	+				+														

OCCURRENCE OF EACH SPECIES—CONTINUED

	NAME OF BIRD	Blue-winged teal	Shoveler	Pintail	Wood duck	Redhead	Lesser scaup duck	Ring-necked duck	Snow goose	Canada goose	Bittern	Least bittern	Great blue heron	Little blue heron	Green heron	Black-crowned night-heron	Virginia rail	Sora
Habitat divisions	Building																	
	Yard																	
	Field																+	
	Pasture																	
	Road																	
	Orchard																	
	Sprouts																	
	Timber edge																	
	Bluff																	
	Creek timber																	
	Salix-Pop														+	+		
	Slough	+													+			+
	Typha											+	+		+	+	+	+
	Lake shore	+	+								+		+	+	+	+		+
	Lake	+	+	+	+	+	+	+					+		+	+		
	Creek												+		+			
	River				+				+	+			+		+			
Month	December																	
	November	+	+				+	+		+								
	October	+		+	+						+		+					
	September	+		+	+						+		+	+	+	+	+	+
	August	+			+							+	+		+	+		+
	July												+		+			
	June	+		+	+		+					+	+		+	+		
	May	+	+	+			+					+	+		+	+		+
	April	+	+	+		+	+			+			+		+	+		
	March		+	+			+		+	+			+					
	February			+			+			+								
	January			+														

OCCURRENCE OF EACH SPECIES—CONTINUED.

NAME OF BIRD.	Month.												Habitat divisions.																
	January	February	March	April	May	June	July	August	September	October	November	December	River	Creek	Lake	Lake shore	Typha	Slough	Salix-Pop	Creek timber	Bluff	Timber edge	Sprouts	Orchard	Road	Pasture	Field	Yard	Building
Coot				+	+	+			+	+	+				+	+	+												
Wilson's phalarope					+											+													
Wilson's snipe				+	+					+	+			+		+	+	+											
Long-billed dowitcher					+				+							+													
Stilt sandpiper					+											+													
Pectoral sandpiper			+	+	+	+		+	+	+					+	+													
White-rumped sandpiper					+	+		+	+							+													
Least sandpiper					+	+		+	+							+													
Semipalmated sandpiper					+	+		+	+							+													
Hudsonian godwit					+											+													
Greater yellowlegs				+					+						+														
Yellowlegs			+	+	+	+		+	+	+					+	+													
Solitary sandpiper				+	+			+	+					+	+	+		+											
Willet					+			+							+	+													
Buff-breasted sandpiper								+								+													
Spotted sandpiper					+	+	+	+	+				+	+	+	+		+											
Long-billed curlew					+											+													

OCCURRENCE OF EACH SPECIES—CONTINUED

	Name of Bird.	Black-bellied plover	Killdeer	Semipalmated plover	Bobwhite	Mourning dove	Turkey vulture	Marsh hawk	Sharp-shinned hawk	Cooper's hawk	Red-tailed hawk	Red-shouldered hawk	Swainson's hawk	Broad-winged hawk	Rough-legged hawk	Bald eagle	Sparrow hawk	Osprey
Habitat divisions	Building					+												
	Yard					+												
	Field					+									+			
	Pasture					+											+	
	Road				+	+											+	
	Orchard					+												
	Sprouts																	
	Timber edge										+	+						
	Bluff				+	+	+	+		+	+	+	+	+	+	+		
	Creek timber				+	+						+						
	Salix-Pop				+	+	+	+	+	+	+	+		+				
	Slough					+			+									
	Typha					+												
	Lake shore	+	+	+		+												
	Lake	+		+		+				+								
	Creek					+												
	River																	+
Month.	December				+	+					+				+			
	November					+				+	+	+						
	October		+		+	+		+		+	+				+			
	September		+	+	+	+	+	+		+	+	+		+			+	
	August	+	+	+	+	+	+	+		+	+	+		+				+
	July				+	+	+			+	+	+						
	June	+	+	+	+	+	+	+		+	+			+				
	May		+	+	+	+	+		+	+	+	+		+				
	April		+		+	+	+	+		+	+		+					
	March		+		+	+		+			+					+		
	February					+		+	+	+	+					+		
	January				+	+		+		+	+				+	+		

OCCURRENCE OF EACH SPECIES—Continued.

Name of Bird.	Month.												Habitat divisions.																
	January	February	March	April	May	June	July	August	September	October	November	December	River	Creek	Lake	Lake shore	Typha	Slough	Salix-Pop	Creek timber	Bluff	Timber edge	Sprouts	Orchard	Road	Pasture	Field	Yard	Building
Long-eared owl			+																+										
Short-eared owl	+		+									+							+										
Barred owl										+	+								+		+								
Saw-whet owl			+																+										
Screech owl	+	+	+	+	+	+	+	+	+	+	+	+								+	+			+				+	+
Great horned owl				+		+	+	+	+	+		+								+	+								
Yellow-billed cuckoo					+	+	+	+	+	+					+	+	+		+	+	+	+	+			+		+	
Black-billed cuckoo					+	+		+	+										+		+								
Belted kingfisher			+	+	+	+	+	+	+	+			+	+	+			+											
Hairy woodpecker	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+			+				+	+
Downy woodpecker	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+			+				+	
Red-headed woodpecker	+	+	+	+	+	+	+	+	+	+									+	+	+	+			+			+	+
Red-bellied woodpecker	+	+	+	+	+	+	+	+	+	+	+	+								+	+			+				+	+
Northern flicker	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+	+			+			+	+
Whippoorwill				+	+	+	+	+	+											+	+								
Nighthawk					+			+	+						+													+	
Chimney swift				+	+	+	+	+	+	+					+				+									+	+

OCCURRENCE OF EACH SPECIES—CONTINUED

	Name of Bird.	Ruby-throated humming bird	Kingbird	Crested flycatcher	Phœbe	Olive-sided flycatcher	Wood pewee	Acadian flycatcher	Alder flycatcher	Least flycatcher	Prairie horned lark	Magpie	Blue jay	Crow	Cowbird	Yellow-headed blackbird	Red-winged blackbird	Meadow lark
Habitat divisions.	Building				+													
	Yard	+	+	+	+		+						+	+			+	
	Field	+	+								+			+	+		+	
	Pasture	+													+			+
	Road		+		+						+		+		+		+	+
	Orchard	+	+															
	Sprouts																	
	Timber edge		+															
	Bluff	+	+	+	+	+	+	+	+	+			+	+	+		+	
	Creek timber	+	+	+	+		+			+		+	+	+	+		+	
	Salix-Pop	+	+	+	+		+	+	+	+			+	+	+		+	
	Slough				+											+	+	
	Typha															+	+	
	Lake shore													+		+		+
	Lake		+		+									+		+	+	
	Creek		+											+				
	River		+											+				
Month	December												+	+			+	
	November												+	+	+		+	+
	October												+	+	+		+	+
	September	+	+	+	+	+	+		+	+			+	+	+		+	+
	August	+	+	+	+	+	+	+	+	+			+	+	+		+	+
	July	+	+	+	+		+	+					+	+	+		+	+
	June	+	+	+	+		+	+	+		+		+	+	+		+	+
	May	+	+	+	+		+		+	+			+	+	+	+	+	
	April			+	+				+	+	+		+	+	+		+	
	March				+								+	+	+		+	
	February										+		+	+			+	
	January											+	+	+			+	

OCCURRENCE OF EACH SPECIES—CONTINUED.

NAME OF BIRD.	Month.												Habitat divisions.																
	January	February	March	April	May	June	July	August	September	October	November	December	River	Creek	Lake	Lake shore	Typha	Slough	Salix-Pop.	Creek timber	Bluff	Timber edge	Sprouts	Orchard	Road	Pasture	Field	Yard	Building
Orchard oriole					+	+	+	+	+								+		+	+	+							+	
Baltimore oriole					+	+	+	+	+										+	+	+							+	
Rusty blackbird				+							+	+							+		+							+	+
Bronzed grackle	+		+	+	+	+	+	+	+	+	+	+				+			+	+	+				+	+	+	+	
Purple finch	+	+	+	+	+					+	+								+		+								
Goldfinch	+	+	+	+	+	+	+	+	+	+	+	+		+	+		+		+	+	+	+			+		+	+	
Pine siskin	+	+	+								+	+							+	+	+								
English sparrow	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+		+				+	+	+
Savannah sparrow				+															+		+								
Grasshopper sparrow						+			+																		+		
Leconte's sparrow				+														+							+				
Lark sparrow					+	+	+		+											+					+	+	+		
Harris' sparrow	+	+	+	+	+					+	+	+							+	+	+				+			+	
Gambel's sparrow					+														+										
White-throated sparrow				+	+					+	+								+	+	+								
Tree sparrow	+	+	+	+						+	+	+					+	+	+	+	+				+				
Chipping sparrow				+	+	+																					+	+	

OCCURRENCE OF EACH SPECIES—CONTINUED.

	Name of Bird.	Clay-colored sparrow	Field sparrow	Slate-colored junco	Song sparrow	Lincoln's sparrow	Swamp sparrow	Fox sparrow	Towhee	Cardinal	Rose-breasted grosbeak	Indigo bunting	Dickcissel	Scarlet tanager	Summer tanager	Purple martin	Cliff swallow	Barn swallow
Habitat divisions.	Building																	+
	Yard			+						+	+	+			+	+		+
	Field		+	+		+	+	+				+	+					+
	Pasture		+	+	+								+					+
	Road	+	+	+				+		+		+	+				+	+
	Orchard		+			+				+	+	+	+					+
	Sprouts		+		+					+		+	+					
	Timber edge		+		+					+		+	+					
	Bluff		+	+	+	+		+	+	+	+	+	+	+	+	+		
	Creek timber		+	+	+	+	+	+	+	+	+	+	+	+	+			
	Salix-Pop		+	+	+	+	+	+	+	+	+	+	+			+		+
	Slough				+	+	+					+	+					
	Typha				+	+	+									+		+
	Lake shore																	+
	Lake															+		+
	Creek																	
	River																+	
Month.	December			+	+	+	+		+	+								
	November			+	+	+	+	+	+	+								
	October		+	+	+	+	+	+	+	+		+						
	September		+	+		+			+	+	+	+	+			+	+	+
	August		+						+	+	+	+	+	+	+	+	+	+
	July		+						+	+	+	+	+	+	+	+		+
	June		+						+	+	+	+	+	+	+	+	+	+
	May		+		+	+	+		+	+	+	+	+	+		+	+	+
	April	+	+	+	+	+	+	+	+	+			+		+	+		+
	March		+	+	+	+	+	+	+	+								
	February			+	+	+		+	+	+								
	January			+	+			+	+	+								

OCCURRENCE OF EACH SPECIES—CONTINUED.

NAME OF BIRD.	Month.												Habitat divisions.																
	January	February	March	April	May	June	July	August	September	October	November	December	River	Creek	Lake	Lake shore	Typha	Slough	Salix-Pop	Creek timber	Bluff	Timber edge	Sprouts	Orchard	Road	Pasture	Field	Yard	Building
Tree swallow				+	+	+	+	+	+					+	+	+	+		+		+				+				
Bank swallow					+	+	+	+	+				+	+	+										+				
Rough-winged swallow				+	+	+	+	+	+				+	+	+				+		+		+		+	+	+	+	+
Cedar waxwing	+		+	+	+	+		+	+		+								+	+	+							+	
Migrant shrike			+			+	+	+	+												+				+		+		
Red-eyed vireo					+	+	+	+	+										+	+	+								
Philadelphia vireo									+											+									
Warbling vireo					+	+	+	+	+									+	+	+	+			+				+	
Yellow-throated vireo				+	+		+	+	+										+		+								
Blue-headed vireo					+			+	+	+									+	+	+								
White-eyed vireo					+	+	+	+	+										+	+	+	+							
Bell's vireo					+	+	+	+	+										+	+	+	+	+	+	+	+			
Black-and-white warbler				+	+	+		+	+									+	+	+	+							+	
Prothonotary warbler					+	+		+	+						+				+	+	+							+	
Worm-eating warbler							+		+										+		+								
Blue-winged warbler						+		+	+										+		+								
Nashville warbler					+			+	+										+		+								

OCCURRENCE OF EACH SPECIES—CONTINUED

NAME OF BIRD	Month												Habitat divisions																
	January	February	March	April	May	June	July	August	September	October	November	December	River	Creek	Lake	Lake shore	Typha	Slough	Salix-Pop	Creek timber	Bluff	Timber edge	Sprouts	Orchard	Road	Pasture	Field	Yard	Building
Orange-crowned warbler				+	+					+									+	+									
Tennessee warbler					+			+	+	+									+		+								
Northern parula warbler				+	+	+	+	+	+										+	+	+								
Yellow warbler				+	+	+	+	+	+										+	+	+			+				+	
Myrtle warbler				+	+					+	+								+	+	+							+	
Magnolia warbler					+																+								
Cerulean warbler						+															+								
Black-poll warbler								+																				+	
Blackburnian warbler									+												+								
Black-throated green warbler								+	+											+									
Pine warbler									+											+									
Ovenbird					+			+	+										+		+								
Grinnell's water thrush					+			+	+						+	+	+	+	+									+	
Louisiana water thrush				+										+															
Kentucky warbler				+	+	+	+	+	+									+	+	+	+	+							
Mourning warbler					+			+	+									+	+	+	+								
Northern yellowthroat					+	+	+	+	+								+	+	+	+	+				+				

OCCURRENCE OF EACH SPECIES—CONTINUED.

NAME OF BIRD.	Month.												Habitat divisions.																
	January	February	March	April	May	June	July	August	September	October	November	December	River	Creek	Lake	Lake shore	Typha	Slough	Salix-Pop.	Creek timber	Bluff	Timber edge	Sprouts	Orchard	Road	Pasture	Field	Yard	Building
Yellow-breasted chat					+	+	+	+	+								+	+	+	+	+	+	+		+	+			
Wilson's warbler					+			+	+										+	+	+								
Canada warbler					+			+											+		+								
Redstart				+	+	+	+	+	+									+	+	+	+		+						
Mocking bird						+		+																	+				
Catbird					+	+	+	+	+	+									+	+	+			+	+			+	
Brown thrasher				+	+	+	+	+	+	+									+	+	+	+	+		+				
Carolina wren	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+				+				+
Western house wren				+	+	+	+	+	+	+									+	+	+			+	+			+	+
Winter wren		+	+							+	+						+				+			+	+				
Short-billed marsh wren					+														+										
Prairie marsh wren				+	+	+		+	+	+							+	+	+										
Brown creeper	+	+	+	+						+	+	+							+	+	+			+				+	
White-breasted nuthatch	+	+	+					+		+	+	+							+	+	+							+	
Red-breasted nuthatch	+	+	+	+							+								+	+	+							+	
Tufted titmouse	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+	+						+	
Chickadee	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+			+	+			+	

OCCURRENCE OF EACH SPECIES—CONCLUDED.

NAME OF BIRD.	Month.												Habitat divisions.																
	January	February	March	April	May	June	July	August	September	October	November	December	River	Creek	Lake	Lake shore	Typha	Slough	Salix-Pop	Creek timber	Bluff	Timber edge	Sprouts	Orchard	Road	Pasture	Field	Yard	Building
Golden-crowned kinglet	+	+	+							+	+	+							+	+	+								
Ruby-crowned kinglet			+	+					+	+									+	+	+								
Blue-gray gnat catcher				+	+	+	+	+	+										+	+	+	+							
Wood thrush					+	+	+	+	+										+	+	+							+	
Gray-cheeked thrush					+																+								
Olive-backed thrush					+																+								
Hermit thrush				+																	+								
Robin	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+			+			+	+	
Bluebird	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+	+		+	+	+	+	+	+

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Reactions of the Formamidines. XII: Some Derivatives of Desoxybenzoin.

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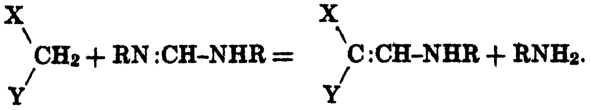
In a previous series of papers, (*1*) it has been shown that one of the characteristic properties of compounds containing the acid methylene grouping was their ability to react with disubstituted formamidines, producing a carbon-carbon linking, and yielding an amino-methylene derivative, as follows:



$$\begin{matrix}X \\ \quad\diagdown \\ \quad\quad CH_2 \\ \quad\diagup \\ Y\end{matrix} + RN{:}CH\text{-}NHR = \begin{matrix}X \\ \quad\diagdown \\ \quad\quad C{:}CH\text{-}NHR \\ \quad\diagup \\ Y\end{matrix} + RNH_2.$$

Such reactions were found to occur in the case of open-chain compounds such as aceto-acetic ester, benzoyl-acetic ester, cyano-acetic ester, and acetyl-acetone; and also with the heterocyclic thiazolidones, pyrazolones, isoxazolones and imidazolones.

The following work shows that the methylene hydrogen of the grouping $C_6H_5\text{-}CH_2\text{-}CO\text{-}$ in desoxybenzoin (benzyl-phenyl ketone) may be replaced, with difficulty, forming reactive amino-methylene derivatives of the type $C_6H_5\text{–}CO\text{–}C(C_6H_5){:}CH\text{–}NHR$. In general, the ease of reaction is determined by the acidity of the methylene grouping; thus compounds containing the complex $CO\text{–}CH_2\text{–}CO$ substitute the hydrogen of the $\text{–}CH_2\text{–}$readily and smoothly. On the other hand, experiments with camphor have failed to yield an amino-methylene derivative.

EXPERIMENTAL.

PREPARATION OF BENZYL-PHENYL KETONE. (*2*.)

Benzoin was heated with zinc dust in glacial acetic acid for twenty-four hours. The reaction mixture was then poured into cold water and the oil which separated extracted with ether. This solution was then dried with calcium chloride, the ether distilled off, and the residue fractionated under reduced pressure. An average yield of sixty per cent pure desoxybenzoin, boiling at 185-190° at 15 mm. and melting at 55° was thus obtained, a yield decidedly better than afforded by other methods.

ANILIDOMETHYLENE-DESOXYBENZOIN.

$PhCOC(Ph)\ CHNHPh$.

A mixture of diphenyl formamidine (24 grams) and desoxybenzoin (24 grams) was heated at 155° in a distilling flask under reduced pressure for two hours. An oil distilled over, which proved to be aniline. The temperature of the bath was then raised to 190° for 15 minutes. The reaction mixture was then treated with dilute acid to remove any unchanged formamidine and then purified by recrystallizations from alcohol.

Analyses: Calculated for $C_{21}H_{17}ON$; N, 4.67%.
Found: 4.63% and 4.55%.

The yellow compound, which melted at 93.5°, is identical with the one obtained by Wislicenus and Ruthing by the action of aniline upon formyl desoxybenzoin, $Ph–CO–C(Ph):CHOH$. (3.)

p-TOLYL-AMINO-METHYLENE-DESOXYBENZOIN.

This compound, together with p-toluidine, was formed by heating under reduced pressure desoxybenzoin with di-p-tolyl formamidine. The monoclinic crystals from alcohol melted at 132°.

Analyses: Calculated for $C_{22}H_{19}ON$; N, 4.47%.
Found: 4.43% and 4.51%.

p-METHOXY-PHENYL-AMINO-METHYLENE-DESOXYBENZOIN

$PhCOC(Ph)\ CH\text{-}NH\text{-}C_6H_4OCH_3$.

Under like conditions at 165°, desoxybenzoin and di-p-anisyl formamidine gave a very poor yield of the above compound, cubical crystals from alcohol, with a melting point of 127°.

Analyses: Calculated for $C_{22}H_{19}O_2N$; N, 4.26%.
Found: 4.31%.

The general reaction involved in all of the above reactions is as follows:

$$Ph–CO–C(Ph)H_2 + RN–CH–NHR = Ph–CO–C(Ph):CHNHR + RNH_2.$$

The yields are unsatisfactory; the best obtained was 14% with di-p-tolyl formamidine, while the results with the di-o-tolyl and di-p-ethoxyphenyl formamidines were negative. The trouble seems due to the difficulty of finding the optimum temperature of reaction in each case and the ease with which deep-seated decomposition products are formed.

REACTIONS OF THE AMINO-METHYLENE DERIVATIVES.

(a) *Acids and Alkalies.*

The p-tolyl compound was unaltered after boiling for four hours with 15% sulphuric acid, or for one hour with 20% sodium hydroxide solution.

(b) *Alcoholic Potash.*

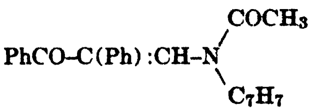
When refluxed for two hours with alcoholic potassium hydroxide solution, the p-tolyl compound was broken down into p-toluidine and benzoic acid.

(c) *Acetyl Derivative.* $(C_{22}H_{18}ON)COCH_3$.

The p-tolyl derivative was heated for ten hours with acetic anhydride. The excess of anhydride was decomposed with warm water, and the resulting solid crystallized from hot alcohol. It melted at 111°.

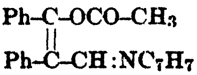
Analyses: Calculated for $C_{24}H_{21}O_2N$; N, 3.94%.
Found: 3.71% and 3.67%.

Warming with dilute potassium hydroxide splits off the acetyl group, yielding the original paratolyl-amino-methylene-desoxybenzoin. Such an acetyl compound could be either a p-tolyl acetamino derivative such as:



$$\mathrm{PhCO{-}C(Ph){:}CH{-}N}\begin{matrix}\diagup\,\mathrm{COCH_3}\\ \diagdown\,\mathrm{C_7H_7}\end{matrix}$$

Or more probably the acetate of the enol form:



$$\begin{array}{l}\mathrm{Ph{-}C{-}OCO{-}CH_3}\\ \quad\ \Vert\\ \mathrm{Ph{-}C{-}CH{:}NC_7H_7}\end{array}$$

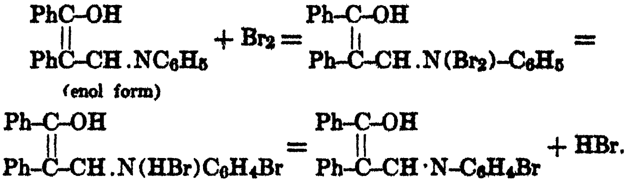
(d) *Action of Bromine upon Anilido-methylene-desoxybenzoin.*

P-Bromo-phenyl-amino-methylene-desoxybenzoin.

One mole of bromine was added to a cooled solution of anilido-methylene-desoxybenzoin in chloroform. One standing, a crystalline yellow compound separated out which melted, with decomposition at 144°. This, when treated with water, lost hydrobromic acid and gave a bromo compound which melted at 167° after recrystallization from alcohol.

Analyses: Calculated for $C_{21}H_{17}ONBr$; N, 3.66%.
Found: N, 3.73% and 3.86%.

The substance when boiled with alcoholic potash gave benzoic acid and parabromoaniline. This fact, together with the analysis, shows the validity of the above formula. The probable mechanism of the reaction is as follows:



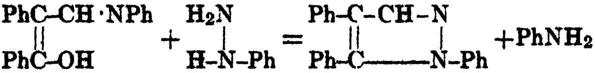
$$\begin{array}{l} PhC-OH \\ \| \\ PhC-CH.NC_6H_5 \\ \text{(enol form)} \end{array} + Br_2 = \begin{array}{l} Ph-C-OH \\ \| \\ Ph-C-CH.N(Br_2)-C_6H_5 \end{array} =$$

$$\begin{array}{l} Ph-C-OH \\ \| \\ Ph-C-CH.N(HBr)C_6H_4Br \end{array} = \begin{array}{l} Ph-C-OH \\ \| \\ Ph-C-CH\cdot N-C_6H_4Br \end{array} + HBr.$$

(e) *Synthesis of Ring Compounds.*

1-4-5 Triphenyl Pyrazole

It was shown in earlier papers that the grouping R–CO–CH: CH–NHR′ will condense in the enol form with hydrazines and yield pyrazoles (*4*). This is true in the present case, since the anilidomethylene compound when boiled with phenyl-hydrazine in alcoholic solution gave the well-known 1-4-5 triphenyl pyrazole (m.p. 212°). (*5.*)



$$\begin{array}{l} PhC-CH\cdot NPh \\ \| \\ PhC-OH \end{array} + \begin{array}{l} H_2N \\ | \\ H-N-Ph \end{array} = \begin{array}{l} Ph-C-CH-N \\ \| \qquad\quad | \\ Ph-C\text{———}N-Ph \end{array} + PhNH_2$$

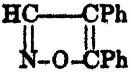
Analyses: Calculated for $C_{21}H_{16}N_2$; N, 9.46%.
Found: 9.41%.

The same pyrazole and paratoluidine were obtained when p-tolylamino-methylene-desoxybenzoin was treated under similar conditions with phenyl hydrazine.

4-5 Diphenyl Pyrazole.

The p-tolyl derivative when heated with hydrazine sulphate and potassium carbonate in alcoholic solution combined readily to give p-toluidine and the 4–5 diphenyl pyrazole (m.p. 158°).
Analyses: Calculated for $C_{15}H_{12}N_2$; N, 12.72%.
Found: 12.61% and 12.64%.

Synthesis of 4-5 Diphenyl Isoxazole.



$$\begin{array}{l} HC\text{——}CPh \\ \| \qquad \| \\ N-O-CPh \end{array}$$

Paratolyl-amino-methylene-desoxybenzoin (ten grams) and hydroxylamine hydrochloride (5 grams) were heated for four hours in a mixture of alcohol (25 cc.) and pyridine (10cc.). On pouring into an excess of cold dilute hydrochloric acid, an oil separated which soon solidified. The filtrate contained p-toluidine and the solid after recrystallization melted at 74.5°.

Analyses: Calculated for $C_{15}H_{11}ON$; N, 6.34%.

Found: 6.18% and 6.44%.

The compound when boiled for a few minutes with 15% sodium hydroxide was hydrolyzed into benzoic acid and small amounts of an oil with the odor of benzyl cyanide. The identity of the compound is proven, then, as 4-5 diphenyl isoxazole, both by its analyses, its decomposition products, and its analogy with the synthesis of other isoxazoles by Dains and Griffith. (*6*.)

SUMMARY.

(1) Certain derivatives of R-amino-methylene desoxybenzoin have been synthesized.

(2) Their behavior with acids, alkalies, acetic anhydride and bromine has been studied.

(3) They have been found to give, with phenyl hydrazine, hydrazine and hydroxylamine, pyrazole and isoxazole ring compounds.

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(7) The authors wish to thank the Research Committee of the University of Kansas for a grant which was of essential aid in this investigation.

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I. Synthesis of Thiazane Derivatives.

II. Reactivity of Various Alkyl Bromides With Diphenyl Thiourea.*

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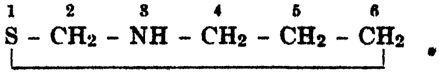
Part I.

Synthesis of Thiazane Derivatives.

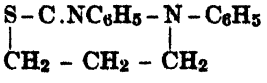
THE meta-thiazanes are six membered heterocyclic ring compounds consisting of four carbon atoms with a nitrogen and sulphur atom meta to each other.

The following formula illustrates the simplest reduced meta-thiazane ring and its numbering:



$$\overset{1}{S} - \overset{2}{CH_2} - \overset{3}{NH} - \overset{4}{CH_2} - \overset{5}{CH_2} - \overset{6}{CH_2}$$

(*a*) Derivatives of this type were first synthesized by F. Foerster (*1*) by the action of trimethylene dibromide upon thiocarbanilide, which gave 2-phenylimino-3-phenyl-1-3-thiazane.



$$\begin{array}{l} S-C.NC_6H_5-N-C_6H_5 \\ | \qquad\qquad\qquad\quad | \\ CH_2 - CH_2 - CH_2 \end{array}$$

(*b*) They have been obtained, also, by the interaction of trimethylene dibromide (*2*) or chlorobromide (*3*) with thioamides.

(*c*) And from gamma halogenated amines with carbon disulphide, alkali rhodanides, mustard oils or thioamides (*4*).

(*d*) The loss of water from gamma-oxy-thioureas (*5*) and various syntheses involving the loss of water from thioderivatives (*6, 7, 8*) has resulted in the same type of ring closure.

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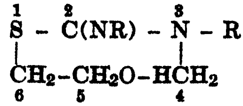
* From a thesis submitted to the graduate faculty of the University of Kansas in partial fulfillment of the requirements for the degree of doctor of philosophy.

In the chemical laboratory of the University of Kansas such meta-thiazanes have been prepared easily and smoothly from alpha-propanol-alpha-beta-diaryl thioureas, $RNHCSNRCH_2CH_2CH_2OH$. When such compounds are heated with acids, the ring is closed, yielding 2-arylimino-3-aryl-m-thiazanes (*9*), $S\text{-}C(NR)NRCH_2CH_2CH_2$.

The present paper is a study of some interesting derivatives of these thiazanes which contain an hydroxyl group in position 5 and have the general formula:

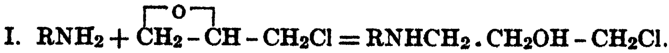


EXPERIMENTAL.

SYNTHESE OF 2-ARYL-IMINO-3-ARYL-5-HYDROXY-1, 3-THIAZANES FROM AMINES, EPICHLORHYDRIN AND MUSTARD OILS.

The general reactions involved in this synthesis are as follows:

Cohn and Friedlander (*12*) have shown that epichlorohydrin adds to primary amines with the formation of a gamma-chloro-beta-hydroxy derivative of a secondary propyl-aryl-amine.



$$\text{I. } RNH_2 + \overbrace{CH_2 - CH}^{O} - CH_2Cl = RNHCH_2 . CH_2OH - CH_2Cl.$$

Aryl-isothiocyanates (*11*) have been found to unite with the substituted amine, forming a thiourea.

$$\text{II. } RNHCSN(R)CH_2CHOHCH_2Cl.$$

which is too unstable to be isolated, but with loss of hydrogen chloride goes over to the 5-hydroxy thiazane.

In practice the following general procedure has been found advisable. Alcoholic solutions of the amine and epichlorohydrin are allowed to stand in a covered beaker for twelve hours or more and the mustard oil dissolved in alcohol is then added. The solution on slow evaporation in the air gradually deposited crystals mixed with a semi-solid residue. This mass is extracted at water-bath temperature with dilute hydrochloric acid (1:5), the extraction being repeated with fresh acid if necessary.

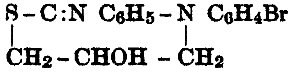
The acid solution is cooled, allowed to stand over night and filtered from the insoluble residue.

The clear filtrate is now poured into an excess of ice-cold dilute ammonium hydroxide, and the solid thiazane, after drying, is purified by repeated crystallizations from alcohol and from benzene.

The product, insoluble in acid, was found to consist of substituted thioureas from the mustard oil and unchanged amine and unidentified oily residues.

THIAZANES SYNTHESIZED.

2-PHENYL IMINO-3-p-BROMO PHENYL-5-HYDROXY-1, 3-THIAZANE.



Materials Used.

34.4 g. p-bromo aniline.
18.5 g. epichlorohydrin.
27 g. phenyl mustard oil.
100cc. alcohol.

The yield of thiazane was 20 grams, which melted after recrystallization from alcohol or benzene at 177°.

Analyses: Calculated for $C_{16}H_{15}ON_2SBr$; N, 7.71.

Found: N, 7.52%, 7.36.

The hydrochloride had a melting point of 191°.

From the acid-insoluble portion in this preparation was isolated 4-bromo-diphenyl-thiourea.

2-p-TOLYL IMINO-3-BETA-NAPHTHYL-5-HYDROXY-1, 3-THIAZANE.

Materials Used.

15 g. beta-naphthyl amine.
10 g. epichlorohydrin.
12 g. p-tolyl isothiocyanate.
200 cc. alcohol.

The yield was six grams, with a melting point of 152° when crystallized from alcohol.

Analyses: Calculated for $C_{21}H_{20}ON_2S$; N, 8.05.

Found: N, 8.23.

2-p-TOLYL IMINO-3-PHENYL-5-HYDROXY-1, 3-THIAZANE.

Materials Used.

50 g. aniline.
50 g. epichlorohydrin.
80 g. p-tolyl isothiocyanate.
100 cc. alcohol.

The thiazane which was obtained in 44% yield was purified from alcohol and had a melting point of 139°.

Analyses: Calculated for $C_{17}H_{18}ON_2S$; N, 9.40.

Found: N, 9.43, 9.21.

2-o-TOLYL IMINO-3-o-TOLYL-5-HYDROXY-1, 3-THIAZANE.

Materials Used.

107 g. o-toluidine.
92.5 g. epichlorohydrin.
149 g. o-tolyl mustard oil.
250 cc. alcohol.

The thiazane from alcohol had a melting point of 139° to 140° and only 22 grams of the pure base were isolated.

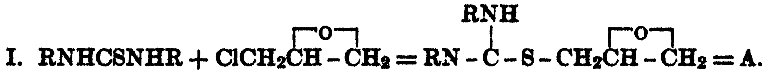
Analyses: Calculated for $C_{18}H_{20}ON_2S$; N, 8.98%.

Found: N, 9.21%, 8.87%.

SYNTHESES OF 2-ARYL IMINO-3-ARYL-5-HYDROXY-1, 3-THIAZANES FROM DI-SUBSTITUTED THIOUREAS AND EPICHLOROHYDRIN.

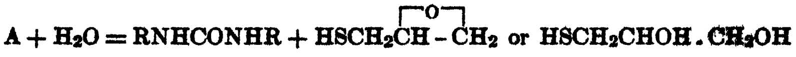
In previous papers (*14*) it was shown that thiocarbanilide and epichlorohydrin gave the same diphenyl hydroxy thiazane that could be formed from aniline, epichlorohydrin and phenyl isothiocyanate. Further work has indicated that the mechanism of the reaction between the thiourea and epichlorohydrin is as follows:

First, a thioether is formed:



$$\text{I. } RNHCSNHR + ClCH_2\overbrace{CH-CH_2}^{O} = RN-\overset{RNH}{\overset{|}{C}}-S-CH_2\overbrace{CH-CH_2}^{O} = A.$$

Second, the ethylene oxide grouping can add to the RNH group, thus closing the ring and yielding the thiazane or the thioether can react with water and give an oxyurea RNHCONHR and a mercaptan:



$$A + H_2O = RNHCONHR + HSCH_2\overbrace{CH-CH_2}^{O} \text{ or } HSCH_2CHOH.CH_2OH$$

The evidence for the above series of reactions is the fact that thiazanes identical with those previously obtained and oxyureas were isolated and positive proof of the formation of a mercaptan obtained. The observation that thioureas are disulphurized by boiling in aqueous solution with ethylene chlorohydrin would seem to confirm the above explanation. The following case will illustrate the general experimental method:

2-PHENYL IMINO-3-PHENYL-5-HYDROXY-1, 3-THIAZANE.

Materials Used.

50 gr. thiocarbanilide.
25 g. epichlorohydrin.
100 cc. alcohol.

The mixture was heated for eight hours on the water bath. The alcohol was then distilled off. From the residue in the flask was isolated diphenyl urea, m. p. 234-5° and the thiazane (*19*), with a melting point of 175°.

Analyses: Calculated for $C_{16}H_{16}ON_2S$; N, 9.86.

Found: N, 9.82, 9.95.

2-P-TOLYL IMINO-3-P-TOLYL-5-HYDROXY-1, 3-THIAZANE.

Materials Used.

30 g. di-p-tolyl thiourea.
21 g. epichlorohydrin.
50 cc. alcohol.

The mixture was heated for two hours and then extracted with dilute hydrochloric acid to remove the base. The purified thiazane weighed 12 grams and melted at 142-142.5°.

Analyses: Calculated for $C_{18}H_{20}O_2N_2S$; N, 8.98.

Found: 8.77, 8.76.

The residue, insoluble in acid, was di-p-tolyl urea.

2-o-TOLYL IMINO-3-o-TOLYL-5-HYDROXY-1, 3-THIAZANE.

Materials Used.

60 g. di-o-tolyl thiourea.
42 g. epichlorhydrin.
100 cc. alcohol.

The mixture was heated until everything went into solution. From the reaction product was isolated di-o-tolyl urea and the thiazane, 19 gms. This, after recrystallization from alcohol, melted at 139-140°.

Analyses: Calculated for $C_{18}H_{20}ON_2S$; N, 8.98.

Found: N, 9.21, 9.16.

DI-m-XYLYL IMINO-3-m-XYLYL-5-HYDROXY-1, 3-THIAZANE.

Epichlorohydrin and the di-xylyl thiourea gave the usual products, di-xylyl urea and the thiazane which after purification from alcohol melted at 146°.

Analyses: Calculated for $C_{20}H_{24}ON_2S$; N, 8.24.

Found: N, 8.24.

REACTIONS OF THE 5-HYDROXY-THIAZANES.

1. Oxalic Acid.

Equal amounts of dehydrated oxalic acid and di-p-tolyl-hydroxythiazane were heated at 140° for an hour with the hope that a mole of water might be split off, leaving an unsaturated ring compound. No reaction occurred and the thiazane was recovered unchanged.

2. *Hydrochloric Acid.*

The thiazane was unaffected on boiling for eight hours with hydrochloric acid (1:1).

3. *Methyl Iodide.*

No definite products were isolated when the diphenyl thiazane was allowed to stand with or heated at its boiling point with methyl iodide.

4. *Oxidation of the Diphenyl-Hydroxy-Thiazane.*

The thiazane (26 g.) was dissolved in 100 cc. glacial acetic acid, diluted with 200 cc. water. To this a solution of potassium permanganate was slowly added. The permanganate was reduced, but the only definite product isolated was a little unchanged thiazane. It was thought that the secondary alcohol group might be oxidized to a keto grouping, but instead the ring is evidently disrupted. An effort was made to synthesize such a keto compound $S{-}C=(NR){-}NR{-}CH_2COCH_2$ as follows:

ACTION OF ALPHA, GAMMA DICHLORO ACETONE ON THIOCARBANILIDE.

Thiocarbanilide (45 g.) and the dichloroacetone (25.4 g) were dissolved in 550 cc. of dry acetone and the mixture allowed to stand in a stoppered flask. After four days wartlike growths of light brown crystals began to appear. In the course of 12 days some 50 g. of the salt had separated from the solution.

STUDY OF THE HYDROCHLORIDE.

Some of the crystalline material from the foregoing reaction was pulverized and kept over the week end in a desiccator containing H_2SO_4, connected with suction, before weighing out samples for analyses and study of properties.

SOLUBILITY.

The solubility of this material in various solvents was observed. With water it gave an acid solution and a curdy-white residue. Alcohol readily dissolved it. In chloroform it first dissolved, but very quickly a chalk-white precipitate formed. It was sparingly or slowly soluble in benzene, toluene, petroleum ether, and ether. Acetone dissolved it more readily.

MELTING POINT OF SALT.

The melting point of the material dried in the desiccator was: darkened, 155°; blackened, 185°; fused, 187°. Melting point of some of the material precipitated from chloroform solution, after washing with chloroform and drying, was: darkened, about 150°; blackened, about 180°; fused, 186-187°. A sample of the original growth of crystals, after washing with acetone, crystallizing from alcohol, again washing with acetone, gave as melting point: darkened, 160-170°; fused, 188-190.5°. Some of the material dried in the desiccator, crystallized from benzene, washed with acetone, gave as melting point: darkened, 185-190°; fused, 195-196°.

This data on melting points, the results of solubility tests, and the method of formation, with the following analysis, point to these wartlike deposits being a hydrochloride of a base.

AMOUNT OF HYDROGEN CHLORIDE IN THE HYDROCHLORIDE.

Some of this hydrochloride was suspended in water and its acidity determined by running in a measured amount of NaOH solution and titrating back with H_2SO_4 solution. With methyl red as indicator: found 12.22% and 11.62% HCl. With phenolphthalein as indicator: found 12.16% and 12.35% HCl. Average of all determinations is 12.21% HCl.

TOTAL CHLORINE IN THE HYDROCHLORIDE.

The amount of chlorine in the hydrochloride was determined by the liquid ammonia method (*15*). The first set of analyses gave 23.56% and 23% and 29% of Cl. The second set of determinations gave 20.40% and 20.33% of Cl. It was thought that the variation in analyses of the two sets of samples might be due to variation in the period of drying.

HYDROCHLORIDE CONTINUES TO LOSE WEIGHT ON HEATING.

A weighing bottle filled with the hydrochloride was placed in a drying oven at 50-60°. At the end of 27 days the sample was still losing weight.

Day of experiment.	Weight of bottle and sample, grams.	Day of experiment	Weight of bottle and sample, grams.
1	14.0402	22	12.3524
3	13.0975	23	12.3436
7	12.8451	24	12.3367
9	12.8251	25	12.3339
16	12.5149	27	12.3271
20	12.3784	28	12.3240
21	12.3594		

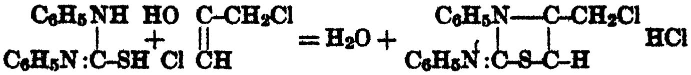
NITROGEN IN THE HYDROCHLORIDE.

The amount of nitrogen in the hydrochloride was determined by the Gunning method: found 8.17% and 8.16%.

STUDY OF THE BASE.

The hydrochloride was dissolved in dilute hydrochloric acid, filtered from a little insoluble portion and the filtrate poured into an ice-cold ammonium hydroxide solution. A white precipitate was obtained which was purified by repeated crystallization from benzene and acetone. The resulting base contained chlorine and melted at 152°.

The results of the following analyses show that the original compound contains two atoms of chlorine, one in the form of hydrogen chloride and the other rather loosely bound in the molecule. The most probable explanation is that the dichloroacetone reacts with the thiocarbanilide in the enol form yielding 2-phenyl imino-3-phenyl-4-chloro methyl-thiazolin.



$$\begin{array}{ccccc} C_6H_5NH\;\;HO & C{-}CH_2Cl & & C_6H_5N{-\!-\!-}C{-}CH_2Cl & \\ |\quad + & \| & =H_2O+ & |\qquad | & HCl \\ C_6H_5N{:}C{-}SH\;\;Cl & CH & & C_6H_5N{:}C{-}S{-}C{-}H & \end{array}$$

Analyses: Calculated for the salt $C_{16}H_{13}N_2SCl$, HCl:

$N = 8.31$; $HCl = 10.83$; $Cl_2 = 21.07$.

Found: $N = 8.17$; $HCl = 12.21$; $Cl_2 = 20.40$;
8.16. 20.33.

Calculated for the free base: $C_{16}H_{13}N_2SCl$; $N = 9.32$. Found: 9.20.

Confirmatory evidence for such a thiazol synthesis was found in the work of Traumann (*16*), who obtained 2-phenyl imino-3-phenyl-4-methyl thiazolin by the action of monochloroacetone upon thiocarbanilide.

SUMMARY.

1. A number of 2-aryl imino-3-aryl-5-hydroxy-1, 3-thiazanes have been made from aryl amines, epichlorohydrin and aryl mustard oils.

3. It has been shown that epichlorohydrin will disulphurize thioureas, converting them into the corresponding oxygen ureas.

4. The action of various reagents upon the hydroxy thiazane has been studied.

5. Dichloroacetone was found to give, with diphenyl thiourea, a thiazolin.

PART II.

Reactivity of Various Alkyl Bromides with Diphenyl Thiourea.

PRELIMINARY NOTICE.

IN the hope that light might be thrown on the nature of the reaction between thiocarbanilide and dichloracetone, a study was made of the speed of reactivity of various alkyl bromides with thiocarbanilide. This was done to determine, if possible, which type of alkyl bromide reacted most readily with the –SH group in one of the tautomeric forms of diphenylthiourea.

Earlier work (*17*), as well as more recent investigations in this laboratory (*18*), has shown that a characteristic reaction of substituted thioureas is their ability to add directly alkyl halides yielding thioethers according to the type reaction.

$$\text{R NHCSNHR} + \text{RX} = \text{R NHC(SR)NR.HX}$$

From the hydrogen halide salts thus formed, the action of alkalies sets free the thiourea ethers, with the formation of an alkali halide. This alkali halide may be extracted from the other products with water. The measure of the amount of halide in the aqueous solution should give a measure of the amount of thiourea and alkyl halide which reacted.

METHOD OF PROCEDURE.

The reactions were allowed to take place in a three-necked flask. In the center neck was inserted a water condenser, in the top of which was inserted a small-bore tube to serve as an air condenser. In a second neck was inserted a short-stemmed thermometer, the bulb of which was always kept below the surface of any solution in the flask. In the third neck was inserted a 10 cc. pipette, the inner end dipping into any solution in the flask, the outer end being closed with a short rubber tube and clamp. All insertions were made through tight-fitting corks.

All the reactions were carried out in acetone solution. The calculated weight of thiocarbanilide was put in the flask. About three-fourths of the proper amount of acetone was added. The connections were adjusted and the flask immersed in a water bath. The temperature of this bath was kept at 65-70°. When the solution began to boil, 5 cc. of the alkyl bromide in about half of the remainder of the acetone was carefully poured in through the water condenser and washed down with the balance of the acetone.

The proportions of the three components of the reaction mixture were 2,000 g. acetone: 1 mol of thiocarbanilide: 1 mol of alkyl halide. In each case 5 cc. of the alkyl halide was used. The densities of the alkyl halides necessary for the calculations were taken from Beilstein. The weight of each alkyl hadile being fixed by the product of its density by the volume, 5 cc., the amounts of acetone and thiocarbanilide were calculated to make the right proportions.

From time to time 10 cc. portions of the boiling solution were drawn out and run into flasks containing 10 cc. of saturated sodium bicarbonate solution and 10 cc. of water. After thorough shaking, precipitated material was removed by filtration and washed on the filter until free from halides, using sufficient wash water to make filtrate and washings 100 cc.

Determinations of the halogen in these filtrates was made by the Volhard method.

RESULTS.

The net results of these reactions between alkyl bromides and thiocarbanilide in acetone solution are shown in the following table, all time being measured from the beginning of the reaction involved:

Bromide	*Time*	*Per cent reacted.*	*Remarks.*
Ethyl	2 hrs.	9.62	At end of 3 hrs. 10 min. 12.48 per cent reacted; equilibrium not reached
N-propyl	2 hrs.	12.15	At end of 2 hrs 30 min. 12 48 per cent reacted; equilibrium not reached.
Iso-propyl	2 hrs.	3.01	This was equilibrium; reached by end of 10 min.
N-butyl	2 hrs.	5.72	At end of 3 hrs., 7.82 per cent reacted; equilibrium not reached.
Iso-butyl	1½ hrs.	5.00^{+}	Equilibrium.
Sec-butyl	1 hr.	1.80^{-}	Equilibrium
Ter-butyl	½ hr.	68.29	Maximum per cent reacted commenced to decline.

SUMMARY.

Within the limits of this work, one may arrange these bromides as to relative reactivity with thiocarbanilide in acetone solution in this order:

1. Ter-butyl.
2. N-propyl.
3. Ethyl.
4. N-butyl.
5. Iso-butyl.
6. Iso-propyl.
7. Sec-butyl.

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(17) Claus. Ber. 7, 235 (1874) and 8, 41 (1875); Bernthsen, Klinger, Ber. 11, 492 (1878) and 12, 574 (1879); Bernthsen, Friese, Ber. 15, 566 (1882); Will, Ber 14, 1485 (1881) and 15, 338 (1882); Rathke, Ber. 14, 1774 (1881); Evers, Ber. 21, 962 (1888).
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